The

BALWANT VIDYAPEETH

JOURNAL OF AGRICULTURAL AND SCIENTIFIC RESEARCH

Vol. I. JULY 1959 No. 2

Published by

THE BALWANT VIDYAPEETH, BICHPURI (AGRA)

Balwant Vidyapeeth Journal of Agricultural & Scientific Research

Abbr. *B. V. J. Agri. Sci. Res.*

PUBLISHED BY

THE BALWANT VIDYAPEETH

BICHPURI (AGRA)

Vol. I. No. 2. **Annual Subscription Rs. 8-0-0**

July 1959 **Single Copy Rs. 4-0-0**

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Printed by Nagendra Nath Sharma Goswami at The Coronation Press,
Phulatti Bazar Crossing, Agra. Phone No. 4171

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COMPARATIVE PERFORMANCE OF EIGHT VARIETIES OF WHEAT AT BICHPURI.

G. B. Singh & M. L. Gupta.

Introduction :

Variety is an important requisite in profitable crop production. For better yields a suitable variety needs to be grown under ideal conditions of 'environment'. At present Pb. 591, a late ripener is the most prominent variety of wheat in the Agra tract. But, during the last few years it has shown an increasing susceptibility to loose smut. A stage may come when Pb. 591 has to go out of cultivation due to the fear of this disease. Hence, it appears advisable to find out a suitable alternative to replace this variety, if, such a need arises.

With the above aim in view a wheat varietal trial was planned at B. R. College Research Farm, Bichpuri (Agra) in the *rabi* season of 1956-57. There were eight varieties (Pb. 591, C. 13, N. P. 710, N. P. 718, N. P. 720, N. P. 758, N. P. 125 and N. P. 781) in the experiments which were tested in a simple randomised design of lay out with six replications.

Results :

Various characters on earing, yield and on factors contributing to the plant and acre yield were studied for all the eight varieties. The results are presented below :—

(A) *Mean number of the days, from sowing to initiation and completion of earing, for eight varieties of wheat.*

TABLE 1.

Varieties.	Days from sowing for	
	Initiation of earing.	Complete earing.
C. 13	83.6	89.1
Pb. 591	92.6	100.1
N. P. 125	85.3	89.1
N. P. 710	85.5	90.1
N. P. 718	81.1	84.8
N. P. 720	84.5	87.3
N. P. 758	85.5	91.1
N. P. 781	90.6	95.5
S. E.	0.77	0.71
C. D. at 5%	2.12	2.03

It is seen that N. P. 718 was the earliest to initiate earing (81.1 days after sowing) and to complete it (84.8 days after sowing) while Pb. 591 was the latest, taking 92.5 and 100.1 days respectively.

From the data for initiation of earing it is noted that N. P. 718 was significantly earlier than all the other varieties. Varieties C. 13, N. P. 125, 720, 710 and 758 among which the differences were non-significant, all came out to be significantly earlier to initiate earing, than N. P. 781 and Pb. 591, the differences between the latter two were also non-significant. The sequence for the complete earing is, more or less, the same.

The earing may be considered as an index for maturity. Therefore, from the above results N. P. 718 may be named as early variety, Pb. 591 and N. P. 781 the later ones and the rest medium early.

(B) Yield Studies :

Yield of grain and straw per acre and factors effecting grain yield.

TABLE 2.

Treatments.	Yield of grain in mds.	Yield of straw in mds.	Grain yield affecting factors		
			Smutted heads 1 acre	% of rust affected plants	Lodged area in %
C. 13	18.39	47.8	302.5	100.0	45.2
Pb. 591	23.43	51.6	904.5	92.0	2.0
N. P. 125	18.64	49.1	0.0	100.0	2.0
N. P. 710	22.12	57.4	0.0	42.0	14.0
N. P. 718	23.08	54.1	0.0	22.0	0.2
N. P 720	19.40	49.1	282.0	96.0	0.0
N. P. 758	19.65	52.9	0.0	96.0	12.9
N. P. 781	19.90	46.1	1462.0	96.0	0.0
S. E.	1.5	2.2	Not done.	Not done	Not done.
C. D. at 5%	3.27	6.5			

From the table 2, it is seen that Pb. 591 produced the maximum grain per acre (23.43 mds.) and C. 13 the minimum (18.39 mds.) Pb. 591, N. P. 710 and N. P. 718 among which the differences were non-significant, all produced significantly more than N. P. 758, 720, 125 and C 13. N. P. 781 showed a non-significant increase over N. P. 758, 720, 125 and C. 13. Thus it is seen that there are no material differences between Pb. 591 (23.43 mds.), N. P. 718 (23.08 mds.) and N. P. 710 (22.12 mds.) while the fourth, in order, N. P. 781 produced only 19.90 mds. per acre of grain. Thus it may be concluded from these results that N. P. 718 and N. P. 710 may be looked upon as alternatives to Pb. 591 when it goes out of the field. Since N. P. 718 is an early maturing variety than N. P. 710 and also a good yielder it deserves preference over the latter.

As regards the yield of straw, it is seen that N. P. 710 produced the maximum straw per acre (57.4 mds.) and N. P. 781 the minimum (46.1 mds.). There were no significant variations among the yields for N. P. 710, N. P. 718, Pb. 591 and N. P. 758 and all these produced significantly more straw than N. P. 781 also there were no significant differences between the yields of N. P. 718, Pb. 591, N. P. 758, N. P.

720, N. P. 125, C. 13 and N. P. 781. From these results it may be summed up that N. P. 710, N. P. 718, N. P. 758 and Pb. 591, are good producer of straw giving more than 50 mds. per acre.

As emphasised above, we want an alternative for Pb. 591 due to its increasing susceptibility to diseases. It is seen from the table 2 that Pb. 591 is definitely growing a tendency to fall prey to these two diseases. N. P. 718 and N. P. 710, on the other hand, have been observed to be free of smut but rust attack, to the extent of 22 and 42% respectively has been recorded. This was a rust year due to very moist conditions in the latter half of the crop life and the two N. P. varieties, N. P. 718 and N. P. 710 may be expected to be rust free in normal years.

The yield of grain per acre is composed of the number of plants per acre and the yield of grain per plant. Similarly, the yield of straw per acre is the resultant of the plant population per acre, at harvest, and the yield of straw per plant. The data on these two characters are summarised below.

TABLE 3.

Yield of grain and straw per plant and the number of plants per acre for eight varieties.

Varieties	No. of plants per acre at harvest.	Yield of grain per plant on gms.	Straw yield per plant in gms.
C. 13	358148	2.7	5.0
Pb. 591	367828	4.2	5.4
N. P. 125	373636	2.6	4.6
N. P. 710	392995	3.5	5.2
N. P. 718	360084	4.1	5.0
N. P. 720	389123	2.8	4.4
N. P. 758	399103	2.9	4.6
N. P. 781	392995	3.0	4.4
S. E.	45462	0.2	0.2
C. D. at 5%		0.7	0.6

It is seen that the plant population, at harvest, for different varieties did not vary significantly, therefore, the significant differences in the grain yield per acre, are to be explained by the variations in the yields of grain per plant which are, more or less, in the same sequence as the acre yields (Table 2). An examination of the yields of straw per plant reveals that Pb. 591 produced the maximum quantity of straw per plant, significantly greater than any of the other varieties. Next, inorder, was N. P. 710 producing significantly more straw per plant than the rest. N. P. 718 was third in order showing non-significant increases over C 13, N. P. 125 and N. P. 758 and significant increases over N. P. 781 and N. P. 720.

The yield of grain per plant in the combined function of the number of ear-bearing tillers per plant and the various characters of ear and grains, viz, ear length, number of fertile spikelets per ear, number of grains per ear and the 1000 seed weight. Similarly, the yield of straw per plant is composed of two plant characters, viz, the plant height and the number of total tillers per plant. Therefore, to explain the above variations in the plant yield these contributing factors to the per plant grain and straw yield are summarised in the following table :

TABLE 4.

Mean results for the factors contributing to the yield of grain and straw per plant.

Varieties.	Factors contributing to grain yield/plant.					Factors contributing to the yield of straw yield/plant.	
	No. of ear bearing Tillers.	Length of ear in cm.	No. of fertile spiklets per ear.	No. of grain per ear.	1000 seed weight in gms.	Plant height in cm.	Total No. of Tillers.
C. 13	1.8	8.0	16.1	35.5	41.4	123.3	2.5
Pb. 591	1.9	8.3	18.5	43.	44.2	123.3	3.0
N. P. 125	1.1	6.6	16.3	36.	36.8	112.3	2.0
N. P. 710	1.9	8.0	19.5	47.5	39.8	120.6	3.0
N. P. 718	2.1	8.0	18.5	44.3	39.6	122.6	2.9
N. P. 720	1.2	6.8	16.6	36.1	41.4	102.8	2.1
N. P. 758	1.3	7.3	17.5	37.3	40.9	118.5	2.4
N. P. 781	1.4	7.8	16.6	37.1	38.7	112.5	2.3
S. E.	0.13	0.20	0.6	1.54	0.22	3.8	—
C. D. at 5%	0.35	0.54	1.56	4.09	0.58	10.5	—

An examination of the data on different factors, contributing to the yield of grain per plant (table 4), go to justify that the three prospective varieties viz. Pb. 591, N. P. 718 and N. P. 710, are superior to other varieties under study. There is one very notable feature about N. P. 718, in the yield contributing factors, that 1000 seed weight is significantly lower than that for Pb. 591, N. P. 720, C. 13 and N. P. 758 and non-significantly lower by N. P. 710. But this adverse seed character failed to lower the grain yield of N. P. 718 due to good tillering in plants and better ear characters.

Similarly, examination of the data on different factors contributing to the yield of straw per plant, it is seen that the height of the plant and the number of tillers per plant are, more or less, in the same sequence as the straw yield per plant.

Conclusions :

Pb. 591, N. P. 718 and N. P. 710 emerged out to be the first best for grain yield with per acre yields of 23.43, 23.08 and 22.12 mds. respectively, the differences among them being non-significant. As Pb. 591 is tending to deteriorate, year after year, due to high infestation of diseases, in the Agra tract, N. P. 718 and N. P. 710 may be looked upon as its successor. Since N. P. 718 is an early variety and also has shown a better yield than N.P. 710 it deserves preference over the latter.

THE EFFECTS OF DIFFERENT POTASH—FERTILIZERS APPLIED WITH AND WITHOUT MUNICIPAL COMPOST ON THE YIELD AND QUALITY OF POTATO CROP (Solanum Tuberosum, L.)

Raghuraj Singh & Suresh Chandra Modgal.

Introduction.

The importance of potash in potato cultivation is well known. Several workers (Maskell, 1927 ; and Russell and Garner, 1941) have indicated its importance mainly for the synthesis of starch in the plant.

The potassium fertilizers are generally available in the form of either potassium sulphate or muriate of potash. The former contains about 48% and the latter contains 40 to 60% of potash. The unit cost of potash is higher in the sulphate form. Even then sulphate of potash is more popular because the chlorine content in the muriate salt affects both the yield and quality of the potato crop adversely (Terman, 1949).

Organic manures such as municipal compost and farm yard manure are known to ameliorate the adverse effect of chlorine in the muriate. A judicious combination of muriate of potash and municipal compost may not, therefore, adversely affect the potato production.

An experiment to test the effect of different levels of potash as applied in two forms viz. potassium sulphate and muriate of potash in the presence and absence of municipal compost on potato crop was planned and carried out in the '*Rabi*' season of 1956-57 at the B. R. College Agricultural Research Station, Bichpuri, Agra. The results of this test are presented and discussed in this paper.

Materials & Methods.

A complex randomized field experiment was laid out to test the following potash treatments with and without a basal dressing of 200 Md./Acre of Municipal compost.

(i) No potash, (ii) KCl One (56 lb. K_2O/Acre), (iii) KCl two (112 lb. K_2O/Acre), (iv) K_2SO_4 one (55 lb. K_2O/Acre) and (v) K_2SO_4 two (112 lb. K_2O/Acre).

Thus there were in all, 10 treatments and these were replicated four times. The net plot size was kept 15'x12' containing 10 rows for yield and quality observations.

The soil samples taken before applying the manures from the experimental area were subjected to the mechanical and chemical analysis. The soil was found to contain 1.780 percent K_2O and [illegible] sandyloam in texture.

The tuber yields and dry matter percentage in tuber samples were statistically analysed. The quality was also measured in terms of the size of tubers. For size, potatoes from each net plot were graded in three grades i. e. (a) diameter above 1.25 inches. (b) diameter from 0.75 to 1.25 inches and (c) diameter below 0·75 inches by the help of standard sieve.

Results and Discussions :

(A) **Yield :**

TABLE 1.

Tuber yield and dry matter production as affected by manuring treatments.

Treatments.	Tuber yield in seers/net plot of 1/242 acres.	Tuber yield in Md./per Acre	Dry matter produced in md. per acre.
1	2	3	4
No potash	30.17	182.52	40.26
56 lb. K_2O/Acre	33.41	202.13	47.80
112 lb. K_2O/Acre	30.79	201.27	45.64
Variance ratio (F)	1.84	—	—
C. D. at 5%	Non-sig	—	—
C. D. at 1%	—	—	—
Potassium Sulphate	32.58	197.10	46.31
Potassium Chloride	31.62	191.30	43.69
Variance ratio (F)	0.30	—	—
C. D. at 5%	Non-sig.	—	—
C. D. at 1%	—	—	—
With compost	34.07	206.12	47.95
Without compost	29.35	177.56	40.16
Variance ratio (F)	9.25**	—	—
C. D. at 5%	3.19	—	—
C. D. at 1%	4.32	—	—
Interaction compost × potash treatments.	Non-sig.	—	—

** Significant at 1% level.

The above table indicates that the differences in tuber yields as affected by potash treatments were not statistically significant, although, level one of potash (56 lb. K_2O/Acre) has given better results than level two of potash (112 lb. K_2O/Acre) and control. Production of dry matter per acre was also affected in the same way. The differences due to forms of potash used were also non-significant although slightly better results for tuber yield and dry matter percent were obtained with the sulphate form.

It may be recalled that, to start with the K_2O content, 1.780% in the experimental area, was quite high (Nijhawan, 1956) and the poor crop response to the potash manuring in this experiment may be considered due to this fact. Lack of crop response to potash applications into soils rich in this element has also been detected by Terman (1950). It is evident, therefore, that the soils containing about 1.780 percent of K_2O may not need high dressings of potash for potato production. For such soils, increased applications above 56 lb. K_2O per acre may not be advisable. For application of such a small amount of K_2O, either form of potash may be used with advantage since the chlorine content in the muriate of potash may not result in any significant decrease in yield.

The above table also reveals that the application of compost significantly influenced the tuber yield and improved the dry matter production considerably.

(B) Quality :

TABLE 2.

Tuber quality as affected by different treatments.

Treatments	Percentage of dry matter in tubers.	Percentage of grades A Above 1·25 inch in diameter.	B 0.75 to 1.25 inch.	C Below 0·75 inch.
1	2	3	4	5
No Potash	22.06	28.99	64.22	6.85
56 lb. K_2O/Acre	23.65	32.94	61.91	5.09
112 lb. K_2O/Acre	22.68	31.81	60.24	7.94
Variance ratio (F)	3.17	0.56	0.73	0.89
C. D. at 5%	Non-sig.	Non-sig.	Non-sig.	Non-sig.
C. D. at 1%	—	—	—	—

Treatments	Percentage of dry matter in tubers.	Percentage of grades A Above 1.25 inch in diameter.	B 0.75 to 1.25 inch.	C Below 0.75 inch.
1	2	3	4	5
Potassium Sulphate	23.50	31.40	61.24	7.34
Potassium Chloride	22.84	33.35	60.91	5.69
Variance ratio (F)	1.41	0.41	0.0001	0.60
C. D. at 5%	Non-sig.	Non-sig.	Non-sig.	Non-sig.
C. D. at 1%	—	—	—	—
With compost	23.27	33.37	59.54	7.05
Without compost	22.62	30.03	63.87	6.11
Variance ratio (F)	1.74	1.51	3.23	0.23
C. D. at 5%	Non-sig.	Non-sig.	Non-sig.	Non-sig.
C. D. at 1%	—	—	—	—
Interaction compost × Potash treatments.	Non-sig.	Non-sig.	Non-sig.	Non-sig.

From the table II, it is quite evident that the treatment effects were non-significant and the quality of tubers remained unaffected by the manurial treatments tested. These type of results, here again, may be attributed to the high potash content of the soil. Any increase in the potash level above 1.780 percent may not be considered helpful to improve the tuber quality.

These findings are in agreement with those of Terman (1950). He also observed similar lack of crop response to potash fertilization in soils rich in K_2O.

The quality of tuber was considerably improved where compost was applied. In potato production the use of organic manures both for high yield and better quality, is considered to be of great advantage. In this study where the crop response to potash treatments was non-significant, ameliorating effects of compost were not possible to evaluate.

Summary and Conclusions :

In 1956-57, a field experiment was conducted at B. R. College Agricultural Research Station, Bichpuri, Agra, to study the effects of different potash fertilizers applied at rates equivalent to 56 and 112 lbs. K_2O per acre. The soil of the experimental area contained 1.780 percent K_2O.

Only slight variations in yield and quality of the produce were noted under different potash treatment combinations. These differences were statistically non-significant. The application of compost improved the yield and quality of the tuber to a considerable extent.

From these findings it may be concluded that in soils rich in potash high dressings of K_2O are not of much use. Applications above 56 lb. K_2O per acre may not be recommended for such soils.

Acknowledgements :

The authors are thankful to Dr. N. K. Anant Rao, Dr. O. P. Gautam and Mr. M. D. Dandawate for their help in preparing this paper.

REFERENCES.

1. Maskell. 1927. Field observations on starch production in leaves of potato. *Ann. Bot. London.*41 : 327—44.

2. Nijhawan, S. D. 1956. Healthy soils make healthy men. *Indian Farming.* 6: 92-93

3. Russell, E. J. and Garner, N. 1941. Rothamsted experiments on manuring of potatoes. Part I ; Effect of Nitrogen, Phosphorus and Potash manuring. *Emp. Jour. Exp. Agri.* Vol. 9 (35) 196-215

4. Terman, G.L. 1949 Effect of source of Potash in the Fertilizer on yield and starch content of potatoes. *Amer. Potato Jour.* 26: 291-299

5. Terman, G. L. 1950 Effect of rate and source of Potash on yield and starch content of potatoes. *The maine Exp. Agri. Sta. Maine Bul.* 481.

INFLUENCE OF RINGING THE SOURCE SHOOTS AND PLANT REGULATOR CONCENTRATIONS ON THE PERFORMANCE OF HARDWOOD CUTTINGS OF KAGZI LIME (Citrus aurantifolia, Swingle).

J. C. Bhutani & S. M. Singh.

Kagzi lime has so far evaded all attempts to propagate it from hardwood cuttings which is the cheapest and most convenient method. Of the various ways of manipulation of these cuttings, ringing the source shoots two weeks before planting and treatment of the cuttings with some plant regulators were reported by Jauhari and Rahman (1958) to have given encouraging results so far as their rooting was concerned, but unfortunately, their work did not say anything about other aspects of the performance of these cuttings including their establishment into new plants.

In view of the importance of the interesting results reported by Jauhari and Rahman (1958) and also of the findings of Hunter (1932) that ringing the source shoots improved the rooting of Rangpur lime, an experiment was conducted to study the effect of ringing and plant regulators on the performance of kagzi lime hardwood cuttings.

Materials and Methods.

Normal healthy shoots with brownish streaks from 20 years old kagzi lime trees were selected and ringed one, two and three weeks before planting of the cuttings. The ringed as well as unringed cuttings were treated with 0, 500, 1000 and 2000 p. p. m. of indole-3-butyric acid in 50% alcohol by the concentrated dip method on 26th September, 1958 before planting them individually in 6" pots filled with 3:1 parts sand and sieved municipal compost. The design of the layout was complex randomised block with 4 replications. 10 pots with one cutting each formed a plot. They were kept under partial shade of lath house.

The cuttings were recorded at fortnightly intervals throughout the experiment and finally examined 12 weeks after planting on 19th December, 1958.

Results.

Rooting, Sprouting and Establishment of Cuttings.

In this experiment the effect of ringing was most marked and a comparison of different treatments of this factor in respect of rooting, sprouting and establishment

was very interesting. Though the treatments had a fairly satisfactory effect so far as rooting of cuttings was concerned, they failed to make the cuttings survive even after rooting (Table I). The death of all the unringed cuttings was not very surprising since even 1% could not root, but the finding that only 3.1% of cuttings could establish out of 52.5% that had rooted and 25% sprouted when ringing was done two weeks before planting, is a little puzzling.

TABLE I

The effect of interval between ringing and planting on rooting, sprouting and establishment of cuttings.

Interval between ringing and planting	Percent rooted	Per cent sprouted	Per cent established
No ringing	0.6	8.1	0.0
Ringing one week before planting	18.1	7.5	3.1
Ringing two weeks before planting	52.5	25.0	3.1
Ringing three weeks before planting	34.0	8.1	1.3
C. D. at 5%	—	7.4	3.4
C. D. at 1%	13.8	9.9	—

The effect of the various concentrations of IBA tried in the present experiment was not much marked.

Root and Shoot Characters.

The cuttings taken from unringed shoots produced poorer growth in respect of number of roots per cutting, length of the longest sprout and the number of leaves, but in case of length of the longest root and number of sprouts per cutting, there was not much difference between ringed and unringed shoots (Table II).

TABLE II

The effect of interval between ringing and planting on root and shoot characters.

Interval between ringing and planting	No. of roots per cutting	Length of the longest root (mm.)	No. of sprouts per cutting	Length of the longest sprout (mm.)	No. of leaves per cutting
No ringing	2.0	40.0	2.0	15.0	0.0
One week	2.8	43.0	1.4	57.1	8.0
Two weeks	2.9	37.0	1.6	33.1	3.0
Three weeks	2.8	45.7	2.1	23.5	3.0

Survival of Cuttings :

Almost all the cuttings were alive for a fortnight after planting, but they died at a rapid rate during the next fortnight (Table III).

TABLE III

The effect of interval between ringing and planting on the survival of cuttings.

Interval between ringing and planting	Percentage of cuttings alive from planting till final recording						
	Sept. 26	Oct. 10	Oct. 24	Nov. 7	Nov. 21	Dec. 5	Dec. 19
No ringing	100.0	100.0	25.0	13.8	0.6	0.0	0.0
One week	100.0	100.0	33.1	18.8	6.3	5.6	3.8
Two weeks	100.0	100.0	41.3	33.1	16.9	15.0	5.6
Three weeks	100.0	99.4	31.3	23.1	9.4	8.1	7.5

The death rate was highest in cuttings that were not ringed, with the result that all of them were dead by the tenth week. Under the three ringings the death rate slowed down after four weeks from planting but it did continue upto the final recording when there was not much difference in the three treatments. The survival of the cuttings under the different concentrations of IBA was also of a similar trend and there was not much difference in the various concentrations including control.

Discussions :

In the present investigation the cuttings taken from unringed shoots showed very poor results, whereas more than half of those taken from ringed shoots produced roots. These findings suggest that probably the hardwood cuttings of kagzi lime are deficient in carbohydrate reserves or some other root initiating substances like hormones which accumulate in the source shoot above the ring. Das, Singh, Parida and Singh (1959) also found a beneficial effect of treating sweet lime cuttings with 200 p. p. m. IAA and 2% sucrose solution.

The best rooting and sprouting of the cuttings was obtained when ringing of the source shoots was done two weeks before planting. An interval of one week between the two operations was probably insufficient for the full effect, and when it was increased to three weeks, some adverse effects were produced. The findings of this experiment, thus, support those of Hunter (1932), and Jauhari and Rahman (1958) who found satisfactory rooting in Rangpur and kagzi limes respectively by ringing the source shoots a fortnight before severing.

Inspite of satisfactory rooting and sprouting the ringed cuttings of kagzi lime failed to establish into new plants beyond 3.1%. It appears that ringing operation induces accumulation of certain substances that help in initiation of adventitious roots in the hardwood stem cuttings, but the cuttings are not able to nurse the new roots properly and, therefore, they can not take up proper functional role. It would be

very interesting to find out why after the formation of roots the cuttings gradually die instead of establishing into new plants. Jauhari and Rahman (1958) did not give any information but that on percentage of rooting. It would have been interesting to know how the cuttings of their experiment performed in respect of establishment. Superior rooting obtained by ringing operation was probably the result of better survival of these cuttings.

The cuttings receiving no plant regulator treatment were as good as those treated with different concentrations of indole-3-butyric acid. With difficult-to-root species, failure of plant regulators to improve the results in hardwood cuttings has been reported by a number of other workers also. Gregory and Overbeck (1945) working with Hibiscus cuttings thought that this may be due to the absence of active internal substances which operate in coordination with the external substance applied to the cuttings.

Summary.

1. Ringing of source shoots before severing had an outstanding effect, and the cuttings taken from ringed shoots were far superior to those from unringed ones. An interval of two weeks between ringing and planting which enabled 52. 5% of the cuttings to root and 25.0% to sprout, proved to be the best. Without ringing only 1 out of 160 cuttings (0.6%) was able to root. The survival as well as the growth of new shoots including the number of leaves formed, was much better in the ringed cuttings.

2. Inspite of better rooting and sprouting of the ringed cuttings, their establishment was extremely poor (only upto 3. 1%).

3. There was not much difference in the performance of the cuttings treated with various concentrations of indole-3-butyric acid, and even untreated cuttings did equally well.

REFERENCES

1. Das, D. N., Singh, B., Parida, G. N. and Singh, R. P. (1959). Studies on the interplay of factors influencing the performance of sweet and kagzi lime cuttings. B. V. J. Agri. Sci. Res. Vol. I No. 1 p. 16-22.

2. Gregory, L. E., and Overbeck, J. (1945). An analysis of the process of root formation on cuttings of a difficult-to-root Hibiscus variety. Proc. Amer. Soc. Hort. Sci. 46, 427-33.

3. Hunter, R. E. (1932). The vegetative propagation of citrus. Tropical Agri. IX (5), 135-40.

4. Jauhari, O. S., and Rahman, S. F., (1958). Investigations in rooting of kagzi lime (Citrus aurantifolia, Swingle) cuttings. Allahabad Farmer. XXXII (2), 40-42.

STUDIES ON SOIL FERTILITY AND PLANT POPULATION RELATIONSHIP IN VEGETABLE CROPS.

I. Effect of Levels of Nitrogen and Spacings on Cauliflower (Brassica oleracea L., var. botrytis).

T. B. Misra, I. J. Singh, G. B. Ohekar and S. M. Singh.

Cauliflower, which is one of the most popular and widely cultivated vegetable crops in India, is very specific in its requirements of nutrients and cultural treatments. The development of its heads mainly depends on the amount of nitrogen available to the plants. Robbins, Nightingale and Schermerhorn (1931) and Carew (1947) found that a marked deficiency in Nitrogen resulted in "buttoning" in this crop. Deficiency of Nitrogen in soil has been reported to be a major factor limiting yields in India (Stewart 1947). For each acre of cauliflower in North India Purewal (1957) recommended the application of 40 tons of farm yard manure supplemented by 5 maunds of Ammonium Sulphate and 2½ maunds each of superphosphate and Potassium Sulphate.

A given level of soil fertility can yield best results only when it is required to maintain an optimum number of Plants. This is specially applicable to a crop like cauliflower where the size of individual heads is as important as the total produce for the most economic returns. It is, therefore, the relationship between the fertility of the soil and the population of plants that would determine the extent of success in commercial production of cauliflower. Haddock (1953) working on sugar beet found that with reduction in spacing resulting in increase in plant population, the fertility of the soil should increase for permitting proper growth of plants.

This paper embodies the results of two experiments conducted to study this relationship in cauliflower with a view to find out suitable plant populations for different levels of soil fertility.

Methods and Materials :

These experiments were carried out during 1957-58 and 1958-59 at the B. R. College Agricultural Research Station, Bichpuri, Agra. In the first year the levels of nitrogen tried were 0, 40, 80 and 120 lbs. per acre in the form of ammonium sulphate of which 20 lbs. nitrogen was applied one month after transplanting and the rest before transplanting. The results of this experiment showed that the yield increased

significantly upto the highest level and, therefore, in the next year the experiment was modified to include some higher doses beyond 120 lbs. The levels of nitrogen tried in the second year were 0, 60, 120, 180 and 240 lbs. per acre, half in the form of ammonium sulphate and half in the form of sieved municipal compost. The nitrogen in the form of compost was applied about a week before transplanting and all but 20 lbs. of that in the form of ammonium sulphate was applied on the date of transplanting. This year also 20 lbs. of nitrogen in the form of ammonium sulphate was given as top-dressing one month after transplanting.

In both the years spacings between plants in the row were kept 1′, 1½′ and 2′ with the rows 1½′ apart. The design of layout was randomised block with 3 and 4 replications in first and second years respectively.

For these experiments the Snowball variety of cauliflower was used. The seedlings were transplanted on 27th November in 1957 and on 19th November in 1958.

Experimental Findings.

Experiment I (1957-58) :

Effect of nitrogen :

The effects of different levels of nitrogen on per acre yield of whole plant as well as curd, diameter and weight of individual curd, and weight per plant are summarised in Table I. Application of nitrogen to cauliflower plants produced significant increase in the per acre yield of the curd as well as whole plant and also in the size and weight of individual plants. The increase brought about by every increase in the level of nitrogen was in most cases significant upto the highest level of 120 lbs. of nitrogen per acre tried in this experiment. It was, however, noted that the maximum increase was brought about by the first 40 lbs. The efficiency of each pound of additional nitrogen became lower at higher levels.

TABLE I

Effects of levels of nitrogen on yield of whole plant as well as curd, diameter and weight of individual curd and weight per plant in 1957-58.

Level of nitrogen in lb. per acre.	Weight of whole plants in mds. per acre.	Weight of curd in mds. per acre.	Diameter of curd in cm.	Weight of curd in chh. per plant.	Weight in chh. per plant.
0	134.72	43.26	7.42	2.0	6.0
40	327.79	132.84	9.03	4.8	11.5
80	396 34	173.63	9.74	6.2	14.2
120	475.22	219.44	12.75	9.1	18.7
C. D. at 5%	39.26	18.18	0.76	0.93	1.67
C. D. at 1%	53.39	24.44	1.04	1.26	2.27

Effect of spacing :

The highest yield of whole plant as well as curd per acre was obtained by spacing the plants 1½′ apart, though the development of individual plants with regard to weight and diameter per curd and the weight per plant was best when the plants were spaced at 2′ in the row (Table II).

TABLE II

Effect of spacing on the yield of whole plant and curd per acre as well as per plant, and the diameter of curd in 1957-58.

Distance between plants in the row.	Weight of whole plant in mds. per acre.	Weight of curd in mds. per acre.	Diameter of curd in cm.	Weight of curd in chh. per plant.	Weight in chh. per plant.
1′	321.71	122.42	8.19	3.4	9.2
1½′	367.63	168.56	10.06	5.7	12.5
2′	311.23	135.91	10.96	7.4	16.2
C. D. at 5%	35.65	15.56	0.66	0.80	1.46
C. D. at 1%	46.82	21.14	0.90	1.09	1.99

Thus, it is clear that the increase in the development of individual plants at wider spacing could not compensate for the lower plant population per unit area. Reduction in spacing from 1½′ to 1′ resulted in significantly smaller individual plants as well as lower yield of curd and whole plant per acre.

Effect of the interaction between nitrogen and spacing :

The interaction between the levels of nitrogen and spacing produced very interesting results on the yield of curd (Fig. 1). Spacing the plants 1′ apart resulted in the lowest yield at all levels of fertility but the differences between the yields at 1′ and 1½′ spacings became much greater when the amount of nitrogen increased beyond 40 lbs. The differences between the yields at 1½′ and 2′ spacings were also not much marked at lower levels of soil fertility ; in fact the former gave slightly lower yield at control, but with an increase in fertility the differences between the yields at these two plant populations also increased. The yield of curd produced at the optimum plant population (1½′ spacing) was, thus, markedly superior to the other two spacings at higher levels of soil fertility.

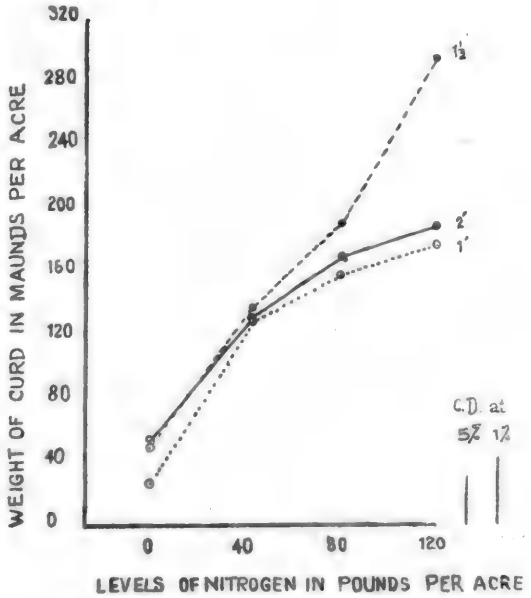


Fig. 1.—Showing the effect of interaction between levels of nitrogen and spacings on the yield of cauliflower curd in 1957-58.

Experiment II (1958-59) :

Effect of nitrogen :

In the second experiment too the use of nitrogen brought about marked increase in the per acre and per plant yield of cauliflower (Table III).

TABLE III

Effect of levels of nitrogen on the yield of whole plant and curd, per acre as well as per plant, and the percentage of marketable heads and diameter of curd in 1958-59.

Level of nitrogen in lb. per acre.	Weight of whole plant in mds. per acre.	Weight of curd in mds. per acre.	Percentage of marketable heads	Diameter of curd in cm.	Weight of curd in chh. per acre.	Weight in chh. per plant.
0	322.18	68.32	74.67	11.4	3.16	15.00
60	438.48	99.24	89.88	13.2	4.58	19.52
120	507.49	133.11	89.00	15.2	6.22	23.79
180	590.40	155.31	93.64	16.0	6.95	26.48
240	607.49	172.06	92.38	17.2	8.40	29.73
C. D. at 5%	42.04	15.85	5.69	0.87	2.94	2.82
C. D. at 1%	55.40	20.89	7.50	1.15	3.88	3.72

There was not much difference in the percentage of marketable heads produced at 60 to 240 lbs. nitrogen per acre but all these were significantly better than control. In respect of other characters including per acre and per plant yields every increase in the level of nitrogen produced considerable increase over the corresponding lower levels though in some cases the differences were not significant statistically. The highest level of 240 lbs. nitrogen per acre, thus, gave the best result.

Effect of spacing :

The increase in spacing between plants from 1′ to 1½′ and also from 1½′ to 2′ increased the development of individual plants appreciably but reduced the per acre yield of curd as well as whole plant of cauliflower (Table IV).

TABLE IV

Effect of spacing on the yield of whole plant and curd per acre as well as per plant, and the percentage of marketable heads and diameter of curd in 1958-59.

Distance between plants in the row.	Weight of whole plant in mds. per acre.	Weight of curd in mds. per acre.	Percentage of marketable heads.	Diameter of curd in cm.	Weight of curd in chh. per plant	Weight in chh. per plant.
1′	535.36	134.33	80.72	13.58	4.93	16.46
1½′	499.78	126.10	90.84	14.72	5.92	23.53
2′	444.52	116.39	92.35	15.60	6.74	25.72
C. D. at 5%	32.66	12.38	4.40	0.68	2.28	1.78
C. D. at 1%	43.04	16.21	5.80	0.89	3.00	2.87

Thus, closer spacing proved better for higher acre yields, but for the growth of individual plants and the size of curd, wider spacing was more suitable.

It was further found that increasing the distance between plants from 1′ to 1½′ increased the percentage of marketable heads significantly but there was not much difference between 1½′ and 2′ in this respect. It would, therefore, appear that plant population at 1½′ distance offered the best compromise between total yield and size of individual plants, since in cauliflower both these factors are almost of equal importance.

Economics of fertility differences :

For finding out the best level of fertility from the point of view of net return, the additional cost of nitrogen over control and the income due to extra yield of curd were worked out at the average market rates. The value of additional produce of

curd was calculated at the rate of Rs. 11.00 per md. Net profit due to extra yield was found out by deducting the cost of additional produce. It was found that though the net return continued to increase due to increases in the levels of nitrogen upto 240 lbs. per acre (Table V), the increases were not proportionate after 120 lbs., suggesting that at 120 lbs. the efficiency of nitrogen was maximum.

TABLE V

Economics of fertility differences

Levels of nitrogen in lb. per acre.	Extra yield of curd in mds. per acre over control.	Income due to increase in the yield of curd over control.	Cost of additional nitrogen	Increase in net income over control
0	—	—	—	—
60	30.92	340.12	41.58	298.58
120	64.79	712.69	83.16	629.53
180	86.99	956.89	124.74	832.15
240	104.74	1152.14	166.32	985.82

However, as the net return from 240 lbs. was about 6 times the cost invested in the additional nitrogen over control, it may be considered advisable to apply 240 lbs. nitrogen per acre to get the highest net income from cauliflower even after meeting the additional expenditure in harvesting and marketing of additional yield which will be brought about by the increase in the level of soil fertility.

Discussion :

The findings of these experiments have shown that cauliflower requires very large amount of nitrogen for producing higher yields of larger heads. The yield continued to increase upto 240 lbs. nitrogen per acre. However, the increase in yield beyond 120 lbs. was not proportionate to the increase in the level of nitrogen, which showed that the efficiency of nitrogen was the highest at this level ; but since the net gain from extra yield increased upto the highest level and was far greater than the cost incurred in the supply of additional nitrogen, the application of 240 lbs. nitrogen per acre proved to be the best. For North India Purewal (1957) also recommended application of very high level of nitrogen for this crop. Under control, where no nitrogen was applied, the size of individual curd was very small which resulted in the lowest per acre yield as well as the percentage of marketable heads. Robbins, Nightingale and Schermerhorn (1931), and Carew (1947), also found similar results in their experiments on this crop.

The performance of individual plants was the best when they were spaced 2′ apart in the row but the highest acre yields were obtained by spacing the plants 1½′ and 1′ apart in the first and second year respectively. In the latter case the size of individual heads as well as the percentage of marketable heads were the lowest. The closest spacing of 1′ was, therefore, insufficient for the development of plants and resulted in greater percentage of smaller heads. Severe competition among plants for nutrient, light and air at this spacing was probably responsible for the poor quality of curd. Two feet spacing between plants provided ample space and nutrient for the development of individual plants but the increase in per acre yield of curd due to increase in size and weight of individual head was rather low to compensate for the reduction in the number of plants per unit area. Since both the size of individual heads as well as per acre yield are equally important in cauliflower, plant population at 1½′ spacing proved to be the best compromise between total yield and the size of curd.

The interaction of soil fertility and plant population in cauliflower was very striking. At lower soil fertility plant populations at 1½′ and 2′ spacings yielded more or less the same, but this was higher than the yield obtained from largest population at 1′ spacing. With the increase in soil fertility the optimum plant population at 1½′ spacing produced better results than either higher or lower one. With largest plant population, even at higher soil fertility, due to limitation of space between plants for development and severe competition for nutrients, the total yield of curd was lowest, whereas with the smallest plant population at 2′ spacing the increase in relative yield per plant could not compensate for the smaller number of plants per unit area. Haddock (1953) reported that when plant population was increased, the competition among plants for nutrients would increase, and, therefore, at closer spacing large amounts of nitrogen were to be added to permit the proper growth of plants. Thus, at lower soil fertility, to get higher yields of cauliflower curd, the density of plants should be reduced by providing 2′ spacing between them, whereas at higher soil fertility the number of plants per unit area may be increased by reducing the spacing to 1½′ in order to make the full utilization of the additional plant nutrients present.

Summary.

The increase in soil fertility up to the highest level of 240 lbs. nitrogen per acre brought about appreciable increase in per acre as well as per plant yield of cauliflower. Application of nitrogen resulted in proportionately greater increase upto 120 lbs. per acre beyond which it became correspondingly less, showing thereby that the efficiency of nitrogen was the highest at this level ; but since the income from extra yield upto the highest level was many times greater than the expenditure involved in the supply of additional nitrogen, the best result was obtained at 240 lbs. nitrogen per acre.

The best size of heads was obtained at the widest plant to plant spacing of 2′ in both the years, but the highest acre yield was produced when the plants were spaced 1½′ apart in the first year and 1′ apart in the second year. In the latter case the percentage of marketable heads was the lowest at 1′ spacing. Since both the size of individual heads and per acre yield are equally important in cauliflower, 1½′ spacing proved to be the best compromise between the two opposing factors of production in this crop.

When the fertility of soil was very low, wider spacing of 2′ between plants gave as good result as closer spacing of 1½′. At higher levels of fertility optimum spacing of 1½′ gave much better results than the narrower as well as wider spacings. The highest plant population gave, on the whole, the poorest result at all levels of soil fertility.

REFERENCES

Carew, H. J. (1947). A study of certain factors affecting "buttoning" of cauliflower. Cornell Univ. Thesis (vegetable crops by H. C. Thompson and W. C. Kelly, 1957. Mc Graw-Hill Book Co., New York, pp. 298-99).

Haddock, Jay. L. (1953). Sugar beet yield and quality as affected by plant population, soil moisture condition and fertilization. Agri. Expt. Sta. Utah State Agr. College. Bull 362.

Purewal, S. S. (1957). Vegetable cultivation in North India. I. C. A. R., New Delhi, Farm Bull 36.

Robbins, W. R., Nightingale, G. T. and Schermerhorn, L. G. (1931). Premature heading of cauliflower as associated with the chemical composition of the plant. N. J. Bull. 509.

Stewart, A. B. (1947) Report on the soil fertility investigations in India with special reference to manuring. Army Press, Delhi.

NUTRITIVE VALUE OF JOWAR (ANDROPOGON SORGHUM) AS A CATTLE FEED.

G. S. Rajorhia, V. N. Bhargava and S. N. Singh

Jowar as a fodder has been extremely popular since indefinite time throughout the country. Its ability to withstand a considerable amount of drought and to grow in areas with scanty rainfall accompanied by its high palatability and anticipated nutritional soundness have made the crop highly acceptable to the livestock owners. But the scientific information on the crop that could be availed of, is too inadequate to be developed into a regular recipe. Only a few investigators have been quoted on the subject in the literature : Ramiah (1934-35), Lander and Dharmani (1936), Schneider et al (1939), Sen (1946, 1953) and Das Gupta (1952) for conducting the digestibility trials on cows at various growth stages of the fodder; Ayyar & Iyer (1934,35) for having studied the mineral balances, Lakke Gowda (1953-54) for studying its composition and Bindal (1958) for investigating its nutritive value by digestibility trial on buffalo heifers.

Thus, because of the paucity of information about this popular fodder crop, the present investigations were planned to see if it can serve as a single maintenance ration in case of buffaloes. The following were the items of the study :—

1. Gross chemical composition of green Jowar at the prime stage of its maturity.
2. Digestibility coefficients of its different nutrients.
3. Balance studies with reference to Nitrogen, Calcium and Phosphorus.
4. Various digestible nutrients and nutritional indices such as D.C.P., S. E., T.D.N., N.R., and Ca : P ratio.
5. Economics of nutrient production.

Experimental Technique.

The metabolic studies were conducted on three almost uniform adult male buffaloes with an average body-weight of 680 lbs. The metabolic trial consisted of 36 days' preliminary feeding on green Jowar alone, followed by a 10-day collection period. During the collection period representative samples of faeces, urine, feed and feed residue were collected daily for the proximate analysis to work out the digestibility coefficients, and Nitrogen, Calcium and Phosphorus balances. The animals were fed ad lib and the daily intake of feed and water was recorded. The

analytical methods employed in the determination of calcium, phosphorus and crude protein were those recommended by A. O. A. C. (1945), while for estimating ether extract and crude fibre the procedures advocated by Wright (1938) were followed. N. F. E. was determined by difference.

Experimental Findings and Discussions.

1. *Chemical composition of Jowar fodder at its prime stage of growth :*

The composite fodder sample of 10-day trial was analysed at the end of the experiment. The results have been presented in Table I.

TABLE I

Showing the composition of Jowar fodder at prime stage of growth expressed as percentage on dry matter basis.

Moisture	Total Ash	Crude Protein	Ether Extract	Crude Fibre	N.F.E.	Total Carbohydrates	Organic Matter	Ca	P
65.00	7.92	4.10	1.61	32.93	53.42	86.35	92.07	0.32	0.08

In general, the composition of Jowar fodder in the present study is in close agreement with the findings of Bindal (1958), Sen (1946), Ramiah (1934,35) and Das Gupta (1943,49). However, wide variations have been reported by Lakke Gowda (1953,54) in respect of protein, calcium (CaO) and phosphorus (P_2O_5) values. Such variations may be due to differences in soil, climate, stage of growth and to a number of other factors.

2. *Digestibility coefficients of different nutrients :*

The digestibility coefficients of different nutrients calculated on the basis of results of the metabolic trial have been tabulated in Table II.

TABLE II

Showing the digestibility coefficients of different nutrients.

Animal No.	Digestibility Coefficient of					
	Dry Matter	Organic Matter	Crude Protein	Ether Extract	Crude Fibre	N. F. E.
A	45.17	50.40	32.46	61.00	50.00	51.79
B	49.75	56.10	35.60	67.63	59.41	50.54
C	44.32	49.80	22.67	49.20	52.37	50.89
Average	46.41	52.10	30.00	59.30	53.92	51.07

Dry matter :

As seen from table II, the digestibility of dry matter ranges between 44.32 and 49.75 with an average of 46.41 percent. Bindal (1958), while working with mature nonpregnant buffalo heifers, also found the average digestibility coefficient of dry matter to be 44.0.

Organic matter :

The average digestibility of organic matter has been observed to be 52.10%. Similar results have also been reported by many other workers. Das Gupta (1949) found the digestibility of organic matter in green Jowar to be 50% on bullocks. Similarly, Iyer (1935) reported it to be 50.85 in Jowar hay prepared at the prime stage of maturity. Mathur and Ray (1943) reported an average digestibility coefficient of 51.0 for organic matter in star grass, the chemical composition of which was more or less similar to the average chemical composition of jowar fodder under study.

Crude Protein :

The digestibility of the crude protein, on an average has been found to be 30.0 percent which favourably compares with several of the previous reports. Lander and Dharmani (1936) reported it, at prime stage to be 36.6. Iyer (1935), on the other hand, while working on second cut (prime stage) hay of Jowar found it to be 31.24 with adult bullocks on Jowar straw and concentrates, Ramiah (1934,35) calculated by difference the digestibility coefficient of Jowar straw proteins to be 34.0. The results of this experiment are also remarkably close to those of Bindal (1958), who observed an average digestibility coefficient of 32.4 for crude protein with mature buffalo heifers.

Ether extract :

Table II reveals that 59.3% of the total ether extract of Jowar fodder at this stage of growth is digestible. Contrary to these results Ayyar & Iyer (1934), Iyer (1935), Das Gupta (1949), Lander & Dharmani (1936) and Bindal (1958) observed lower values for digestible ether extract ranging from 38.6 to 47.0. However, Schneider et al (1939) gave a fairly comparable digestibility coefficient of 63.8 for ether extract in fairly mature jowar fodder.

Crude fibre :

A perusal of figures in Table II shows the average digestibility of crude fibre to be 53.92%. The figures reported by other workers are not very different and the range in the three experimental animals in the present investigation (50.0—59.41) covers the digestibility coefficients reported by many workers. It is interesting to note that the digestibility of crude fibre at this maturity stage of jowar fodder compares very closely with that of its total organic matter.

Nitrogen-free-extract (N. F. E.) :

The average digestibility coefficient of N. F. E. works out to 51.07 (Table II), the range of variability from one animal to another being very small. Slightly higher values averaging to about 60 have been reported by various workers, except Schneider et al (1939) who reported it to be 50.1. But it would be remembered that the coefficient of digestibility for N. F. E. by Schneider et al is for fairly mature samples.

3. *Balance studies with reference to Nitrogen, Calcium and Phosphorus :*

Balance studies involve a quantitative accounting for intake and outgo of specific substances from the animal system representing a gain or loss, within a short period and without sacrificing the animal. Hence the negative balances so obtained, are the manifestations of deterioration of animals, the positive balances are the indications of being on a safer side, while an equilibrium of balance—a lead to economy.

Nitrogen balance :

Table III exhibits the nitrogen balance data of the three experimental animals.

TABLE III

Showing the Nitrogen balance of adult buffaloes on green Jowar alone.

Animal No.	Intake of Nitrogen in gms./ day.	Excretion of Nitrogen in gms./day			Balance gms./day
		Faecal	Urinary	Total	
A	44.178	29.836	11.144	40.980	† 3.198
B	41.982	27.014	11.256	38.270	† 3.712
C	48.752	37.699	9.408	47.107	† 1.645
Average.	44.971	31.516	10.602	42.118	† 2.853

It will be seen from Table III that all the 3 animals were in a positive nitrogen balance. These results calculated on 650 lbs. average live-weight have yielded the positive balances at a level of 0·184 lbs. of D. C. P. intake/day, which when calculated on 1000 lbs. live-weight comes to near about 0.28 lbs. D. C. P. for buffaloes.

Calcium balance :

It will be seen from Table IV that the animals are not able to get their calcium requirement when fed on jowar fodder alone, and exhibit an average negative balance of 5.942 gms. with an average intake of 20.947 gms. per day.

TABLE IV

Showing Calcium balance of buffaloes on green Jowar alone.

Animal No.	Ca intake in gms./day			Ca excretion in gms./day			Balance gms./day.
	Through Jowar	Through Water	Total	Faecal	Urinary	Total	
A	20.286	1.080	21.367	22.666	3.880	26.546	–5.179
B	18.324	0.881	19.205	21.870	3.820	25.690	–6.484
C	21.132	1.137	22.269	25.512	2.920	28.432	–6.163
Average	19.914	1.033	20.947	23.349	3.540	26.889	–5.942

Negative balances of calcium were also reported by Iyer (1935) in whose case two out of three bullocks showed negative balances of CaO when kept on jowar fodder with an intake of 14.4 gms. daily. Rao (1949), on the other hand, has found the requirement of Ca with jowar straw ration to be only 11 gms. for 500 lbs. buffalo bulls.

Phosphorus balance :

An average intake of 5.334 gms. of phosphorus with a total excretion of 3.534 gms. gave a posititive balance of 1.8 gm. per day per head (Table V).

TABLE V

Showing Phosphorus (P) balance of buffaloes on green Jowar alone.

Animal No.	P intake in gms./day	P excretion in gms./day			Balance
		Fæcal	Urinary	Total	
A	5.260	3.730	0.119	3.849	† 1.411
B	4.953	3.020	0.121	3.141	† 1.812
C	5.789	3.500	0.112	3.612	† 2.177
Average	5.334	3.417	0.117	3.534	† 1.800

Similar results have been reported by Ayyar and Iyer (1934) who observed a positive balance of 3.12 gms. P_2O_5 per day per bullock with an average intake of 17.7 gms.

4. *Various Digestible nutrients and nutritional indices:*

On the basis of the detailed chemical composition of Jowar fodder at prime stage of maturity (Table I) and the digestibility coefficients (Table II), the various digestible nutrients and nutritional indices have been calculated and presented in Table VI.

TABLE VI.

Showing the digestible nutrients of green Jowar at the prime stage of maturity and various nutrient indices.

lbs. per 100 lbs. Dry Matter						Dry Matter Basis	
D. C. P.	Dig. Ether Extract	Dig Crude Protein	Dig. N. F. E.	T. D. N.	S. E.	N. R.	Ca : P.
1.23	0.958	17.75	27.28	48.42	28.91	1 : 38	4 : 1

(i) Digestible crude protein (D. C. P.) :

The amount of digestible nutrients available from any feed depends upon its content in the feed and its coefficient of digestibility. So far as the crude protein is concerned, its extent of digestibility as estimated by the conventional method is governed by a number of factors, some of which such as the metabolic faecal nitrogen is beyond control and beyond measure ordinarily. Consequently, its digestibility figure is only apparent and not true. The results contained in Table VI show that the D.C.P. available from 100 lbs. of dry matter of Jowar amounts to 1.23 lbs. Mathur et al (1957) have reported 3.44% D. C. P. on dry matter basis, while Talapatra and Deogoswami (1949) observed 0.84% D. C. P. in the green stuff.

(ii) Total digestible nutrients (T. D. N.) :

The total digestible nutrients as would be available at this particular stage of growth of plant amount to 48.42% on dry matter basis, and are in close agreement, with the values (50.6 to 55.0) reported in literature from several sources (Sen, 1946; Schneider, 1939; Mathur et al, 1957).

(iii) Starch Equivalent (S. E.) :

The S. E. value work out to 28.92 parts per 100 parts of dry matter. Sen (1946) found it to be 32.9 for sorghum silage and 31.0 for ripened Jowar fodder. Talapatra

and Deogoswami (1949) have reported the S. E. value as 7.2 lbs. per 100 lbs. of green Jowar fodder. On the other hand Lander and Dharmani (1936) have found it to be 39.6 for pre-milk stage Jowar.

(iv) Nutritive Ratio :

This is the ratio of the digestible protein to the sum of total digestible carbohydrates and fat, the latter being multiplied by 2.25. As this ratio becomes wider the digestibility of all nutrients tends to be lower. This is particularly true for proteins. The nutritive ratio in this experiment has been worked out to be 1 : 38 which is sufficiently wide, indicating the energy rich nature of the feed in question in relation to that of the digestible crude protein.

(v) Calcium Phosphorus ratio :

For the best utilization of Calcium and Phosphorus a suitable ratio between them has been suggested. According to Maynard (1956) the desirable Calcium and Phosphorus ratio has been defined as one lying between 2 : 1 and 1 : 2. Any deviation from these limits may hamper the economic utilization of the two minerals. The Calcium Phosphorus ratio in this investigation has been noted to be 4 : 1, which shows the predominence of calcium although the animals were in a negative balance.

5. *Economics of nutrient production :*

Feeding costs account nearly for 50 to 60 percent of the total expenditure on management and upkeep of cattle. Thus raising and maintenance of farm livestock becomes an uneconomic proposition, if the items of feeding are expensive. The cost of feeding can be kept down by the rational selection and formulation of rations consisting of economic feeds. The economic feeds are those which yield high returns in terms of dry matter and digestible nutrients per unit of expenditure on production. This takes into consideration the gross yield of various constituents per acre and their digestibility.

On account of high soil fertility the yield of Jowar fodder in the experimental field was remarkably high. Estimation on the lines of crop cutting experiment, which takes into consideration the yield of plots selected at random, the output of green fodder per acre came to 520 maunds per acre with a dry matter content of 35 percent.

Various ingredients—total and digestible, that could be available from this amount of fodder have been calculated and presented in Table VII.

TABLE VII

Showing yield of different nutrients per acre from Jowar at its prime stage of maturity.

Constituent	Total amount (lbs.)	Digestible amount (lbs.)
Dry matter	14924.0	6926.0
Crude protein	610.0	183.0
Ether Extract	241.0	143.0
Crude fibre	4915.0	2649.0
N. F. E.	7972.0	4071.0
S. E.	—	4316.0
T. D. N.	—	7227.0

With Rs. 100.00 as cost of production of Jowar per acre on this farm the cost of various constituents works out as under :

Dry matter	Rs. 0.67 per 100 lbs.
D. C. P.	Rs. 54.64 per 100 lbs.
T. D. N.	Rs. 1.38 per 100 lbs.

Fixing the dry matter consumption of buffaloes at 22 lbs./1000 lbs. body-weight for maintenance as worked out in this experiment the cost of feeding such an animal comes to Re. 0.15 per day for maintenance. Further, on the basis of dry matter requirement of 22 lbs./1000 lbs. live-weight per day and the yield of 520 maunds of Jowar with 35% dry matter, the number of animals that can be maintained per annum on an acre comes to 1.86. These figures are extremely encouraging but subject to such high yields as obtained from this experimental field. Commonly the average yield amounts to 200 maunds per acre and with this as the base the cost of feed for 1000 lbs. animal would be nearly Re. 0.40 for maintenance and the carrying capacity will be reduced to 0.7 animal.

Summary and Conclusion.

In order to evaluate green Jowar fodder on the basis of chemical composition, digestibility of various nutrients, balance studies, economics of nutrient production and to estimate its suitability as a single feed maintenance ration, a metabolic trial was run on 3 male buffaloes which were kept on this fodder alone for 46 days inclusive of 10 days collection period.

During this long period of over six weeks the animals maintained their body weights and remained in good condition.

The balance studies showed that all the 3 animals showed positive balances in respect of nitrogen and phosphorus, the average value being 2.851 and 1.8 gm. per day per head respectively. But all of them exhibited a negative balance of calcium, the average being 5.942 gm./day/head.

It is a rich source of energy and with a normal consumption of 22 lbs. of dry matter per day per 1000 lbs. the animal gets 10.65 lbs. of total digestible nutrients.

With as much as 520 maunds of production per acre as in this experiment and 22 lbs. of dry matter consumption per 1000 lbs. body-weight the carrying capacity of an acre of land has been worked out to be 1.86.

These studies suggest that with suitable calcium supplementation this single feed ration can be balanced to meet the maintenance requirement of adult male buffaloes in respect of protein, calcium and phosphorus, and if its yield can be increased within reasonable limits it will be extremely economical.

REFERENCES

1. A. O. A. C. (1945) : Methods adopted by the Association of Official Agricultural Chemists of U. S. A., 6th edition.
2. Ayyar, N. K. and Iyer, Vishwanath (1934) Indian J. Vet Sci., 2, 108.
3. Bindal, J. P. (1958) Thesis submitted to Agra University for M. Sc. (Ag.) degree. (Unpublished).
4. Das Gupta, N. C. (1943) Indian J. Vet. Sci., 13, 196.
5. „ „ (1949) „ „ „ 4
6. „ „ (1952) Deptt. Agri. & A. H., U. P. Leaflet No. 13.
7. Iyer, A. Vishwanath (1935) Indian J. Vet. Sci., 5, 129.
8. Lakke Gowda. H. S. (1953) Indian J. Dairy Science, 6, 9-14.
9. „ „ (1954) Indian J. Dairy Sci., 7, 19-24.
10. Lauder, P. E. and Dharmani, L. C. (1936) Indian J. Vet. Sci., 6, 117.
11. Mathur, N. L. & Ray, S. C. (1943) Indian J. Vet. Sci., 13, 274.
12. Mathur, N. L. et al. (1957) Indian J. Dairy Sci., 2, 215.

13. Maynard, L. A. & Loosli, K. (1956) " Animal Nutrition ", McGraw Hill Publication. Inc., New York.

14. Rao, H. S. (1949) Quoted by Kehar, N. D. in "Modern concepts of ruminant digestion and metabolism" (Unpublished), at the 7th International Congress on Animal Husbandry (1956) at Madrid.

15. Ramiah, P. V. (1934-35) Quoted by Sen, K. C. (1953) in " Animal Nutrition Research in India ". Macmillan & Co., Ltd., Bombay.

16. Schneider, B. H., Brookes, A. P., Joshi, N. R., Dharni, I. D. and Das, C. O. (1939) Allahabad Farmer, 13, 141.

17. Sen, K. C. (1946) Quoted by Sen, K. C. (1953) in " Animal Nutrition Research in India". Macmillan & Co., Ltd., Bombay.

18. Sen, K. C. (1953) " Animal Nutrition Research in India ". Macmillan & Co., Ltd., Bombay.

19. Talpatra, S. K. & Deogoswami (1949) Indian J. Vet. Sci., 1, 59.

20. Wright, C. H. (1938) " Agricultural Analysis," Thomas Murby & Co., London.

CAROTENE CONTENT OF CATTLE FEEDS.

D. S. Saraswat & S. N. Singh.

Part II—The effect of stage of maturity on the carotene content of some common fodder crops.

The present paper is the second contributed from studies on the carotene content in cattle feeds. It deals with one of the factors that largely influence the content of this vital pigment in leafy materials, viz., the stage of maturity of the crop.

Four common fodder crops of the locality, viz., *Jowar* (Sorghum vulgare), *Guar* (Cyamopsis psoraliode), *Maize* (Zea mays) and *Bajra* (Pennisetum typhoidium) were selected for study. The carotene values of the leaves of these crops were found to be much higher during earlier stages of growth than afterwards when the plants had advanced in maturity. The ranges of carotene values shown by these crops were 353-167, 307-158, 357-186 and 331-179 milligrams per kilogram of dry matter respectively (Table I). The carotene content is not able to keep pace with the dry matter production after the blooming stage and consequently its amount per unit weight of dry matter declines fast with advanced maturity.

A perusal of the results presented in Table I, will denote that in all cases the maximum carotene value per kilogram of dry weight, is attained in 16—29 days after germination. Thereafter a gradual decline is observed for a certain period, being interrupted by a sudden rise of a smaller magnitude in three cases which again finally culminates into a rapid decline towards maturity. The variations in the carotene values of the crops under present study are of a fairly uniform nature. Whatever little difference is there, may be due to plant species difference. The trends in case of *Guar* and *Jowar*, for example, have been characteristic of their growth. It starts from a lower value and reaches the maximum slowly in the former case, whereas in the latter it exhibits a quick initial rise.

Similar results have also been obtained by Sadana and Ahmed (2), who reported that the maximum carotene values were attained in 18 to 28 days after germination, followed by a gradual decline in case of some vegetable crops. The

TABLE I.

Effect of Progressive Maturity on the Carotene Content of Fodder Crops.

Sample No.	*Jowar*			*Guar*			*Maize*			*Bajra*		
	Age in days	Dry Matter percent.	Carotene in mg.	Age in days	Dry Matter percent.	Carotene in mg.	Age in days	Dry Matter percent.	Carotene in mg.	Age in days	Dry Matter percent.	Carotene in mg.
1.	11	16.25	308	15	17.38	176	20	20.80	357	16	19.20	331
2.	18	18.90	353	22	19.10	247	27	21.92	310	23	20.65	327
3.	25	20.00	304	29	20.92	307	34	94.85	293	30	21.00	296
4.	32	21.90	254	36	26.65	264	43	26.63	260	39	24.16	245
5.	42	27.25	210	46	29.65	290	56	30.75	217	52	28.80	229
6.	53	28.05	243	57	29.80	258	62	31.10	210	58	29.97	240
7.	60	36.40	200	64	31.40	208	68	32.85	186	64	31.76	199
8.	71	36.00	171	75	33.70	175	—	—	—	71	33.43	179
9.	81	42.05	191	85	35.50	172	—	—	—	—	—	—
10.	89	43.90	167	93	39.20	158	—	—	—	—	—	—

N. B.—Carotene content has been calculated in milligrams per kilogram of dry matter contained in the leaves of plants.

results agree fairly well with those of other workers making similar studies, for instance, Virtanen (4), Hauge (1) and Seshan and Sen (3).

REFERENCES

1. Hauge, S. M, (1934) Jour. Assoc. Agr. Chem. 17 : 304-307.

2. Sadana, J. C. and Ahmed, B. (1949) Jour. Sci. and Indust. Res. (India) : 8B (3) : 52—56.

3. Seshan, P. A. and Sen, K. C. (1942) Jour. Agr. Sc. 32 : 202—216.

4. Virtanen, A. I. (1936) Nature (Lond.) 137 : 779—780.

DISTRIBUTION OF LABOUR AND EARNINGS IN AGRICULTURE.

Jaipal Singh

The fact that agriculture is too much burdened with an over-supply of labour is very well appreciated and equally well appreciated is the fact that this excessive labour supply forced on agriculture leads to unemployment and under-employment and a low level of income in the rural sector. The conditions of employment and income in agriculture, however, vary with the size of farms. In order to bring about an improvement in the situation it is necessary to gather information regarding the actual conditions prevailing and it is to this end that this survey was undertaken.

Scope and Method.

The information contained in this paper was collected from the village Sheikhpur in Meerut district of U. P. for the year 1949-50. The village had 110 families in all—79 agricultural and 13 non-agricultural. Of the agricultural families 76 were farmers wholly or partly employed in agriculture and 21 were agricultural labourers. This study included 74 farm families—in 2 cases information was denied—following agriculture as a main or subsidiary occupation. These 74 cases have been grouped into five categories according to the size of their farms—group A upto 3 acres (15 cases), group B from 3 to 5 acres (24 cases), group C from 5 to 10 acres (17 cases), group D from 10 to 15 acres (8 cases) and group E above 15 acres (10 cases).

The information collected from the farmers consisted of the details of family members, cropped area and intensity of various farm operations for various crops, production from different crops and the prevailing harvest prices for different commodities for the year 1949-50. It was a year of excessive rains during Monsoons and hailstorm during winters.

Changes in the Volume and Proportion of Agricultural Class.

Changing population and variations in the occupational composition of the community affect the labour supply in agriculture. The following table shows the changes in the volume and proportion of the agricultural class between 1939 and 1950 in the village under study.

Summary of a thesis prepared under the supervision of the Deptt. of Agricultural Economics, B. R. College, Agra and submitted to Agra University for M.Sc. (Ag.) degree in Agricultural Economics in 1951.

TABLE No. I.

Particulars	Agriculturists		Non-Agriculturists		Total	
	1939	1950	1939	1950	1939	1950
1. Number of families	69	97	21	13	90	110
2. % to total families	76.7	88.2	23.3	11.8	100	100
3. Number of persons	513	737	114	72	627	809
4. % to total population	81.8	91.1	18.2	8.9	100	100

An increase in the total number of families and the total number of persons in the village is quite evident from the table but a more interesting fact revealed is the proportion of agriculturists and non-agriculturists which changed from 81.8% and 18.2% in 1939 to 91.1% and 8.9% respectively in 1950. This shows not only a gradual ruralization of the country but also a gradual decline in other rural occupations which now seem to be unable to maintain the artisans and other lower service class people and the rural economy affords very little chances of expansion of such occupations in future. As a result of increasing pressure of population on land there is a constantly worsening situation in agricultural industry. The land-man relationship is changing to the disadvantage of the latter, and level of employment and income from land is gradually going down. The net cultivated area per head in the village between 1939 and 1950 has declined from 0.8 acre to 0.67 acre and the average size of farm from 5.9 acres to 5.0 acres approximately.

Extent of Surplus Labour[1] :

The following table shows the extent of surplus labour in different farm size groups under study during 1949-50.

TABLE No. II.

Farm Size groups	Average Size of Farm (acres)	Labour units available per farm	Labour units utilized per farm	Surplus units per farm	% of Surplus to the total available units.
A (upto 3 acres)	2.5	758.3	401.3	357.0	47.0
B (3—5 acres)	4.9	758.3	450.4	307.9	40.6
C (5—10 acres)	8.7	1013.2	704.0	309.2	30.5
D (10—15 acres)	13.4	1056.2	827.1	229.1	21.7
E (above 15 acres)	20.9	1495.0	1476.4	18.6	1.3
Average	8.5	948.6	678.0	270.6	28.5

On the whole nearly 30% of the available farm labour supply is idle and the surplus is quite significant in case of all the farms upto 15 acres, the period of idleness varying universely with an increase in the size of farm.

Shifting of a part of agricultural population to other occupations, creation of employment opportunities through subsidiary occupations to agriculture and intensification of agriculture itself are some of the important suggestions for solving this problem of surplus labour. Regional distribution of major industries and encouragement to rural industries will be greatly helpful in moving workers out of agriculture. While subsidiary occupations will help small farmers reduce their period of idleness intensification of agriculture will solve the problem of medium and large-sized farmers.

1. The extent of surplus has been worked out on the basis of number of labour units available and the units utilized. For calculating the available labour units in the year (1 unit equivalent to 1 adult workers 8 hour a day labour) women and children units were first converted into adult units by assuming 3 women units equal to 2 and 2 children units equal to 1 adult unit and the total adult units including male adults were then multiplied by 325, the number of working days in the year. The utilization of units is based on the areas under different crops on the farms under study during 1949-50 and the amount of labour units needed for various operations in each crop.

From the view point of progress and economic planning it is desirable to maintain the right quantity and volume of workers in agriculture. Reorganization of agricultural industry itself and a rapid rate of industrialization in the country will be the two important lines of action for achieving this objective.

Earnings in Agriculture.

The following table shows the annual income[2] from agriculture in different farm size groups in the village under study during the year 1949-50.

TABLE No. III.

Farm Size Groups	Income per farm (Rs.)	Income per capita. (Rs.)	Income per acre of total cropped area (Rs.)	Income per acre of net cultivated area. (Rs.)
A	863	166	329	427
B	1671	257	328	385
C	2285	250	261	307
D	2976	283	223	244
E	5895	487	282	316
Total average	2360	293	280	320

Income per farm and per capita is higher in larger size farms while per acre income (both total cropped area and net cultivated area) shows a declining tendency with an increase in the size of farms except that on farms in E group above 15 acres it is higher than C and D groups due to considerably larger areas under sugar-cane, a cash crop.

Improvement in farm technology to minimize the adverse effect of natural hazards on production on the one hand and better prices for agricultural products on the other will improve the farm income greatly. Provision of adequate irrigation facilities, adequate manuring, use of better and improved seeds, reducing the incidence of diseases, insect pests and animals, use of better implements and judicious crop planning are the measures under the former category; while stabilization of agricultural prices and improvement in the marketing and storage of farm products under the latter category.

2. Calculations made from the gross income on different farms worked out on the basis of production of different crops and their prices prevailing at the time of harvest.

STUDIES IN ERUCA SATIVA MILL.

Naresh Mehrotra.

The present investigation on *Eruca sativa* includes its morphology, life history and sterility.

Most of the seeds of *Eruca sativa* are ovoid having an irregular mucilagenous coating more thickly deposited near the micropyle. The germination of seeds is epigeal and the earliest time taken by the radicle to come out is 1.5 to 2.0 days. Plants are 1′—2′ high. The leaves arising near the base of the stem are opposite and subsessile, those in the middle are alternate and petiolate while others that are borne towards the apex are sessile. The period of vegetative phase observed in *Eruca sativa* is of 39 days when the plant possesses 11 leaves on the main stem. There exists a correlation between the development of the main root and laterals, number of laterals and the total area occupied by the root system. Flowers are bracteate, complete, hermaphrodite, actinomorphic, pedicellate, hypogynous and tetramerous. The anthesis is complete in 20 days' time. Flower buds usually open between 8.30 A. M. and 10-30 A. M. The crop is perfectly self-sterile. Fruit setting increases on crossing the long-styled ovaries with stamens from short-styled ones. The order of appearance of floral parts is sepals, androecium, petals and gynaeceum. Anther primordia are four in number of which the mediun ones give rise to two stamens each by bifurcation.

The male archesporial tissue consists of a row of 5 or 6 cells. The wall of an anther consists of an epidermis, the endothecium, 2 middle layers and a binucleate tapetum. The microspore mother cells, by heterotypic division, form microspore tetrads which are decussate and tetrahedral. Pollen grains are spherical and are shed at the bicelled stage.

Ovule is bitegmic and the inner integument only takes part in the formation of micropyle. Female archesporium, which is hypodermal in nature, divides periclinally giving rise to a primary parietal cell and a megaspore mother cell. While the former remains undivided till megaspore mother cell stage, the latter after a prolonged period of rest, divides meiotically to form a linear tetrad of megaspores of which only the

The experiments were done in 1951 under the supervision of Dr. Bahadur Singh, Prof. of Botany, B. R. College, Agra.

chalazal one survives. Three mitotic divisions of the nucleus of the functional megaspore result in the formation of an 8 nucleate embryo sac which is organised to form a seven-celled structure.

Some of the causes of sterility observed in the plant are the shedding of young buds at microspore mother cell stage, the withering of gynaecea, as well as, degeneration of female dyad cells.

REFERENCES

Akhtar, A. R. 1932. Ind. Jour. Ag. Sc. 2 (3) : 280—292.

Ali Mohammad, Singh, R. & Alam, Z. 1931. Jour. Agri. Sci.

Corti, R. 1930. Rchl. (Cruci.) Nuovu giorn. Bot. Ital. 37 : 510—526.

Lund, S. & K. Jaerskon, H. 1836. Not. Tidskr. 15 : 1—151.

Pearson, O. H. 1933. Bot. Gaz. 14 : 524—550.

Riddle, L. C. 1898. Bot. Gaz. 26 : 314—324.

Shafner, Mahall. 1906. Ohio. Nat. 71 : 1—9.

Singh, S. N. 1947. Cawnpore, Agriculture Coll. Mag. Vol. VII Nos. I and 2 : 53—54.

Thompson, H. C. 1933. Jour. Agr. Res. 47 : 215—232.

MORPHOLOGICAL STUDIES IN THE ASCLEPIADACEAE.

H. Y. Mohan Ram.

The author has investigated the life-histories of *Asclepias curassavica* L. and *Cryptolepis buchanani* Roem and Sach, members of Cynanchoideae and Periplocideae respectively, the two sub-families of the family Asclepiadaceae.

Flowers that are borne in axillary Cymes are hermaphrodite and pentamerous with a bicarpellary ovary.

Asclepias has a staminal coronary appendage with a hood and a horn while *Cryptolepis* has coralline corona represented by 5 scales.

Asclepias has bilocular anthers with the pollen of each anther half massed into a pollinium. Two pollinia from adjacent anthers are united by a translator apparatus; *Cryptolepis* has tetralocular anthers with pollen grains remaining in tetrads and collected in spoon-shaped translators with basal adhesive disc.

Microsporogenesis.

The wall of anther of *Asclepias* consists of an epidermis, 4—5 middle layers and 2—3 endothecial layers which develop fibrous thickenings, and single middle layer as well as one layered tapetum.

Divisions of microspore mother cells are successive. While *Asclepias* produces only linear microspore tetrads *Cryptolepis* has isobilateral, tetrahedral, T- shaped and decussate types.

Pollen grains are rich in protein bodies; they are three celled and may sometimes germinate *in situ*.

Megasporogenesis.

Ovules are numerous, anatropus and unitegmic with a narrow micropyle.

Archesporium is hypodermal and it directly functions as megaspore mother cell. It undergoes meiotic divisions resulting in a linear tetrad of 4 megaspores, of which only the chalazal one functions.

The experiments were done in *1953* under the supervision of Dr. Bahadur Singh, Professor of Botany, B. R. College, Agra.

Development of embryo sac is of Polygonum type. Mature embryo sac has 2 pear-shaped synergids with a bigger egg cell in the micropylar end ; two polar nuclei lying appressed below the egg and three antipodal cells in the chalazal region.

Twin embryo sacs were observed in some of the ovules of *Cryptolepis*.

On the above findings it is concluded that the Asclepiadaceae are closely related to the Apocynaceae and the resemblances between Echitoideae of the Apocynaceae is quite considerable with the Periclocoideae of the Asclepiadaceae.

REFERENCES

Agrawal, V. C. (1951) M.Sc. thesis Agra University.

Brongniart, M. A. (1831) Ann. Sci. Nat. Bot. ser. 1, 24 : 263—279.

Brown, R. (1833) Trans. Linn. Soc. London. **16** : 685.

Corry, T. H. (1883) Trans. Linn. Soc. London, 11. Bot. 2 : 75—84.

„ „ (1884) Trans. Linn. Soc. London, 11. Bot. 2 : 173—207.

Dop, P. (1902) C. R. Ac. Paris. **135** : 710—712.

Finn, W. W. (1925) Bot. Gaz. **80** : 1—25.

Frye, T. C. (1902) Bot. Gaz. **34** : 389—413.

Gager, C. S. (1902) Ann. Bot. **16** : 123—148.

Guignard, L. (1903) C. R. Ac. Paris. **137** : 19—24.

Nirula, R. L. (1945) Proc. Indian Acad. Sci. Sect. B. **21** : 174—177.

„ „ (1945) Proc. Ind. Acad. Sci. Sect. B. **21** : 181—185.

Sabet, Y. S. (1931) Ann. Bot. **45** : 503.

Steven, W. C. (1898) Kansas Univ. Quat. Sci. A. **7** : 77—85.

MORPHOLOGY OF ARISTOLOCHIA INDICA LINN.

B. N. Dhar.

The present work was taken into hand to decide the systematic position of the family Aristolochiaceae. While Engler and Prantl, (1889), Rendle (1925) and Gundersen (1950) treat it as a highly evolved and reduced family, Wettstein (1935) keeps it under Polycarpaceae along with primitive magnoliaceous families.

Flowers of *Aristolochia Indica* are bracteate, gamophyllous and hexamerous with an inferior ovary. Placentation in early stages is parietal but in older stages appears axile due to the fusion of extensions of the placentae in the centre.

The organogeny is in the sequence of bract, perianth, carpels, stamens and finally stigmatic papillae.

Floral Anatomy.

Six bundles enter the pedicel, one of them branches to supply the bract. Soon after this the bundles of the pedicel send branches towards the pith where they fuse to form a single concentric vascular strand surrounded by the original ring of six vascular bundles. The central concentric strand divides at the ovary base into 6 collateral vascular traces to the placentae. While the outer ring of six vascular bundles divides into twelve, the alternate 6 of which supply the perianth while the remaining ones enter the gynostegium.

Microsporogenesis.

The wall of the anther consists of an epidermis, a fibrous endothecium, 2 middle layers, and a 2-nucleate tapetum whose cells become amoeboid and form a periplasmodium before their final disintegration.

Reduction divisions of microspore mother cells are successive and result in tetrahedral, isobilateral and linear tetrads of microspores.

Pollen grains are nonaperturate and are shed at the 2-celled stage.

The experiments were done in 1956 under the supervision of Dr Bahadur Singh, Professor of Botany, B. R. College, Agra.

Megasporogenesis.

Ovules are anatropous, bitegmic and crassinucellate. Generally single deep seated megaspore mother cell but occasionally two have been found. Megaspore tetrads may be linear or T- shaped. The chalazal megaspore functions and develops into an eight nucleate embryo sac.

A study of sterile flowers revealed the development of megaspores up to 8-nucleate embryo sac stage. The formation of a layer of cork at the base of the gynostegium and the perianth, of these flowers, however, results in the shedding of these flowers before fertilization.

REFERENCES

Jacobsson-Stiasny, E. (1918) Denkschr. Akad. Wiss. Wien. 95 : 1—13.

Johari, B. M. & Bhatnagar, S. P. (1955) Phytomorphology 5 : 123—137.

Samuelsson, G. (1914) Bedeutung. Svensk Bot. Tidskr. 8 : 181—189.

Venugopalan, S. (1949) Proc. 36th Indian Sci. Cong. (Allahabad) : 137.

AFTER EFFECTS OF LEACHING IN RECLAIMING A SALINE PATCH OF LAND AT THE BICHPURI FARM (B. R. COLLEGE, AGRA).

Ram Neti Singh and B. R. Tripathi.

Introduction.

As is well known, a saline soil (1, 2, 3) is characterized by the following properties :—

1. Electrical conductivity of the saturation extract is more than 4 Milli mhos (mmhos) per centimeter at 25°c.

2. The exchangeable sodium percentage is less than 15.

3. These soils normally have pH values below 8.5.

The salinity of the soil is attributed primarily to the presence of the soluble salts such as :—Sodium, Calcium and Magnesium chlorides and sulphates. Some times small amounts of nitrates and bicarbonates are also present. In addition to the soluble salts, saline soil may contain salts of low solubility such as Calcium and Magnesium carbonates ($CaCO_3$, $MgCO_3$) called lime. Soluble carbonates are generally absent. Sodium seldom comprises more than half of the soluble cations and is not absorbed to any significant extent. The relative amounts of Calcium and Magnesium present in the soil solution and on the exchange complex vary very considerably. Soluble and exchangeable potassium generally are minor constituents.

Saline soils have been commonly called "White alkali" and are distinguished by the appearance of white crusts of salts on the surface and salt streaks along irrigated furrows. Due to the presence of excess salts and the absence of significant amounts of exchangeable sodium, a saline soil is generally flocculated and consequently permeability is equal to or higher than that of normal soils. For reclamation of such saline soils, Leaching irrigation is the recommendation, which carries soluble salts below the zone of root penetration, and improved growing conditions in the soil, are obtained. In other words salinity hazard is eliminated.

In order to reclaim a notoriously saline patch on our Farm at Bichpuri, the programme of Leaching was carried out in the months of April and May. The object

of the present communication is to examine the effect produced in the soil as a result of Leaching.

Plan.

The saline patches were marked out and bunding was made about 1½' high round the plots in question. The patches were levelled up with the help of manual labour. Before putting water on the plot, it was considered necessary to examine the various soil properties of the patch, such as :—

1. Electrical conductivity (E. C.) of the extract of the saturated soil paste by conductivity Bridge.

2. pH of the 1 : 5 soil water suspension by pH-meter.

3. (Ca+Mg) in the saturation extract in me/l (milli-equivalents per litre) by versenate titration (4, 5, 6).

4. Gypsum Requirement (G. R.) in me/100 gm (milli-equivalent per 100 gms. of soil) (7).

5. Hydraulic conductivity in centimeters per hour, and

6. Base exchange capacity (7) (B. E. C.) in me/100 gm.

After making the above determinations, 6" to 8" of water was flooded in the bunded plots. The plots were allowed to get dried and then after about 15 days, another irrigation of about the same intensity was given. The third irrigation was given after about twenty days. Thus the programme of Leaching was carried out at intervals with an idea of letting the soil, be wetted and dried alternately. Having leached the soil thrice in the manner stated above, it was considered necessary to re-examine the soil to find what changes have taken place in the soil and its properties, and therefore the various measurements indicated above, were made again. The results of observations have been recorded in the tabular form as shown in table I and II. The water available for Leaching was from the canal and the Farm tube well. The quality of water has been indicated in table III.

Determinations.

Soil samples were collected from different depths (surface, 6", 18", 30" and 36") from the saline plots in question. For each depth, samples from three places were taken, mixed up and then packed up in bags. These were brought to the Salinity Research Laboratory, where they were air-dried, ground, sieved and then put into the bags. The bags carried the specifications of the soils as to the places and depths, from where they were taken. Soils were taken out from the bags when needed for analysis and determinations.

Saturated pastes of the soils were prepared after the manner indicated in the Agriculture Handbook No. 60, United States Department of Agriculture, and the extract of the saturated soil pastes were obtained with the help of the apparatus made for the purpose. The saturation extracts were subjected to the various determinations detailed below :—

1. Electrical conductivity of the saturation extract, which is used as a measure of the total salinity, was directly determined with the help of sol. Bridge in m-mhos/cm. The results of determinations have been recorded in table I.

2. Soil-water suspensions were prepared for all the soils in question (soil : water : 1: 5) and pH values were obtained with the help of Beckman pH meter. The observations have been tabulated.

3. *Calcium and Magnesium in the Extract* :—The determination of Ca+Mg in the extract was made by titration with Versenate solution using Erichrome Black T as an indicator. Soluble Ca in the extract was separately found by the Versenate—titration but in this case Ammonium purpurate was the indicator. The difference between the two readings yielded the amount of Mg. From this determination, the amounts of Ca+Mg alone have been shown in the respective tables.

4. *Gypsum Requirement* :—The gypsum requirement (G. R.) which is an estimate of gypsum to use in reclamation test as well as a measure of exchangeable sodium, was determined by a quick and simple method (4) as detailed below :—

A saturated solution of chemically pure $CaSO_4 . 2H_2O$ was prepared with distilled water. (The concentration of calcium would be about 29 to 30 me/l in saturated gypsum solution). Now 5 c. c. of the above prepared solution was taken and titrated with standard Versenate of known normality (preferably N/100) and the *volume of the Versenate* required for this titration was noted in c. c.

Then 5 gms of the soil to be tested, was taken in a bottle to which exactly 100 c.c. of the saturated gypsum solution was added. The bottle was stoppered and shaken 5 or 6 times at intervals of ten minutes. The solution was allowed to settle and then filtered. From the aliquot so obtained, 5 c. c. were taken and titrated with Versenate using erichrome black T as indicator. The volume of the Versenate required for this titration was noted for the calculation of Ca+Mg. Method of calculation is indicated below :—

Let the volume of Versenate solution of known strength (say N/100) required to titrate Ca^{++} in 5 c. c. of the prepared saturated gypsum solution be $= V_1$ c. c.

Let the volume of the same Versenate solution required to titrate Ca+Mg, in 5 c.c. of the soil extract be $= V_2$ c. c.

Since 100 c. c. of saturated gypsum solution was used to extract 5 gms. of soil,

$\therefore$ 5 c.c. of the saturated gypsum solution is equivalent to $\frac{5}{100} \times 5 = .25$ gms. of soil.

$\therefore$ m. e. of Ca^{++} —absorbed to replace Na^{+} in .25 gm. of soil

$= (V_1 - V_2) \times$ (Versenate normality factor expresed in m.e.).

$\therefore$ „ Ca^{++} „ in 100 gms. of Soil $= \frac{(V_1 - V_2) \times (\text{Versenate normality}) 100}{.25}$

$= (V_1 - V_2)$ (Versenate normality factor) $\times 400$

This calculation yields the amounts of Ca^{++} in milli-equivalents, needed by 100 gms. of soil for replacement of sodium in it. It may be noted that the bases other than Mg^{++} needed for each 100 gms. of soil = Net gypsum requirement. Calculation shows that, if the net gypsum requirement for 100 gms. of soil is one milli-equivalent, than one ton of 85% gypsum will be required to replace sodium per acre of soil upto the depth of 6''.

5. Hydraulic Conductivity (1) :—The apparatus for this determination was made in the laboratory with the constructive assistance and guidance of Prof. W. R. Schoonover. The hydraulic conductivity values for almost all the samples were determined according to the formula given below :

$$K = \frac{Q \ \triangle L}{A \ \triangle H}$$

K = Hydraulic conductivity.

A = Area of cross-section of the soil column or the inner area of the-cross section of the soil cans, holding the soil.

$\triangle L$ = The length of the soil column.

$\triangle H$ = Height of the water column standing on the soil surface. When-$\triangle L$ and $\triangle H$ are expressed in centimeters, Q in c. c., area in square centimeters and time in hours, conductivity K is expressed in centimeters per hour (cm/hour).

6. Determination of base exchange capacity (7) :—A quick and highly accurate determination of base exchange capacity can be made on alkali soils by

using the gypsum requirement (G. R.) test-method. The principle underlying the method is that the soil in question is at first saturated with Barium and then the G. R. test is made on the Barium-saturated sample. In this process, the reaction runs to completion rather than to equilibrium because the Ba^{++} replaced by Ca^{++} from the gypsum is precipitated. The method is given below in the words of the authors, themselves (W. R. Schoonover, Extension Soils Specialists, and James Quick, Principal, Laboratory Technician University of California) :—

We recommend use of 4-gram sample instead of 5, inorder to supply 75 m. e. of Ca^{++} per 100 g. of soil. This is sufficient for soils of very high exchangeable capacity. In a few cases, we have had to go to lesser amounts of soil.

The procedure is as follows :—Place 4 g. (4 grams) of soil in a small beaker. Wet with 10 to 15 ml. of approximately normal $BaCl_2$ solution. Let marinate until small granules have disintegrated. Wash on to a plain filter paper, using a wash bottle consisting of N. $BaCl_2$ and wash twice more with the $BaCl_2$ sufficiently that the sulphate will precipitate any excess of Ba^{++} which would interfere with the titration. Dry the soil, put in the filter and determine gypsum requirement by the usual procedure, placing soil and filter paper in the 100 ml. of saturated gypsum solution.

One precaution is necessary. Since the Mg^{++} is practically all removed when saturating the soil with Ba^{++}, it is advisable to add a little of some solution containing Mg chelated to the end point in order to secure a sharp end point when using erichrome black T indicator.

The calculation is the same as for gypsum requirement except that 500 is used in the equation instead of 400 to adjust for the difference in size of soil sample.

Thus we get the base exchange capacity in Milli-equivalents per 100 gm. of soil. Since the gypsum requirement is a good measure of exchangeable sodium, the exchangeable sodium percentage will be given by the formula :—

$$\text{Ex—Na\%} = \frac{\text{G. R.}}{\text{B. E. C.}} \times 100$$

Presentation of the Results of Determinations.

As mentioned earlier, the results of the various measurements are given in the tabular form. Results of the examinations of the soil, prior to Leaching are recorded in Table I and the determinations after Leaching programme, are shown in table II.

TABLE I.

Results of determinations before Leaching.

Location and Depth of Soil	Electrical conductivity (m. mhos/cm)	pH of Soil-water suspension (1 : 5)	Ca+Mg in me/l	G. R. in me/100 gm. of soil	Hydraulic conductivity cm/hour	B. E. C. me/100 gm.
W						
1. Surface	350.0	8.2	1300.50	×	×	×
2. 6″	52.5	7.4	193.50	—3.29	0.79	7.72
3. 18″	30.0	7.8	78.75	—1.23	0.44	11.84
4. 30″	28.0	7.9	56.25	+1.64	0.24	11.83
5. 36″	28.0	8.3	54.00	+2.47	0.17	13.39
N						
1. Surface	450.0	8.3	1408.5	×	×	×
2. 6″	55.0	7.9	158.0	4.94	0.41	9.38
3. 18″	31.0	8.2	67.5	×	0.17	7.75
4. 30″	30.0	8.4	49.5	—1.64	0.24	8.24
5. 36″	27.0	8.5	45.0	+4.12	0.39	13.39
C						
1. Surface	225.0	×	1075.50	×	×	×
2. 6″	32.5	7.8	114.75	×	×	×
3. 18″	28.0	7.9	67.50	—0.49	0.49	13.39
4. 30″	30.0	7.8	67.50	—0.41	0.29	12.87
5. 36″	35.0	8.3	69.75	+4.94	0.79	16.99

TABLE II.

Results of determinations after Leaching.

Locations Depth of soil	Electrical conductivity (E. C.) m mhos/cm	pH of soil water suspension (1 : 5)	Ca + Mg in me/1	G. R. in me/100 gm. of soil	Hydraulic conductivity	B.E.C. me/100 gm. of soil
W	cm.					
1. Surface	×	×	×	×	×	×
2. 6″	32	8.2	78.12	6.32	1.02	15.74
3. 18″	22.5	8.5	67.08	2.88	0.56	13.32
4. 30″	23	8.4	25.80	3.89	×	14.04
5. 36″	24.1	8.8	41.28	5.76	×	10,08
N						
1. Surface	×	×	×	×	×	×
2. 6″	15.0	8.7	66.50	0	2.4	9.72
3. 18″	11.5	7.8	32.25	-5.16	0.92	15.48
4. 30″	9.2	8.1	43.46	1.88	1.22	12.38
5. 36″	8.0	8.4	95.46	1.01	×	15.12
C						
Surface	×	×	×	×	×	×
1. 6″	34	8.0	52.89	0	0.48	10.44
2. 18″	16	7.8	65.79	-1.63	1.05	—

TABLE III.

Results of the determinations of the quality of water available on the farm.

S. N.	Source of water	Electrical conductivity (m mhos/cm)	Ca + Mg (me/l)	Cl (me/l)	$H CO_3$ (me/l)	SO_4 (me/l)
1.	Canal	0.3	2.30	0.4	2.59	0.80
2.	Farm well	1.3	4.05	1.4	8.57	2.15
3.	Tube well I	2.5	6.40	7.4	10.06	8.50
4.	Tube well II	1.7	5.50	1.4	8.57	3.03

It may be pointed out that the canal and Tube well I water was used in Leaching the soil in the present investigation.

Discussion of Results.

I. *Electrical conductivity* :—In order to discuss the changes in the electrical conductivity due to leaching, the average values of the E. C. of the soil for the three locations (W. N. C.), have been separately shown below :—

TABLE IV.

1 S. No.	2 Depth of the soil samples	3 Average Electrical conductivity, before leaching (m mhos/cm)	4 Average Electrical conductivity after leaching (m mhos/cm)	5 Percentage reduction in E. C.
1.	Surface	342.0	×	—
2.	6″	46.5	26.6	43%
3.	18″	29.6	16.6	45%
4.	30″	29.3	16.2	45%
5.	36″	30.0	24.1	20%

It will be seen from this table that at all depths, there has been considerable reduction in the electrical conductivity (43%, 45%, 45%, 20%). In other words, due to leaching process, salinity has been decreased to a very great extent. Further it will be noticed that the average electrical conductivity for various depths from surface to 36", varies from 30 to 342 m mhos/cm, before leaching. In view of that fact that a soil is classed saline just when, the electrical conductivity goes beyond 4 m mhos/cm, one comes to the conclusion that patch under investigation suffers from extreme salinity hazard. The programme of leaching has done pretty good job in reducing the salinity by sending down the soluble salts.

This patch, before effecting the leaching, looked and actually was barren. Even grasses, many of which are very salt tolerant, could not grow in previous years, but after leaching in summer there came up fairly good stand of grass in the said saline patch as is evident from the photographs, but even now, the extent of salinity is too high for crop growth. This will need more leaching. The problems challenging the rapid improvement are the following :—

(1) The water table very often rises considerably which hinders the effect of leaching,

(2) The drainage is far from being satisfactory. The improvement of drainage conditions needs priority.

II. pH *Values* :—The table below shows the average pH values for soil water suspension (1 : 5) of the soils before and after leaching.

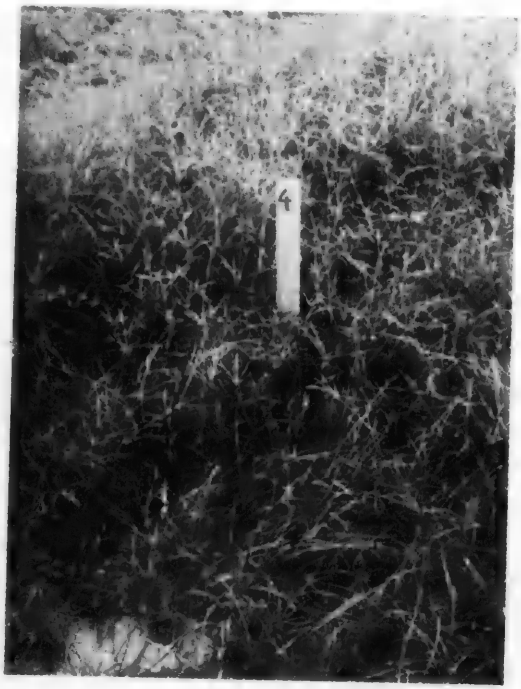
TABLE V.

S. No.	Soil depths	pH values of the soil water suspension (1 : 5) before leaching	pH values of the suspension after leaching
1.	Surface	8.3	×
2.	6"	7.7	7.6
3.	18"	8.0	8.0
4.	30"	8.0	8.3
5.	36"	8.4	8.6

(Fig. No. 1)

(Fig. No. 2)

(Fig. No. 3)



(Fig. No. 4)

The observations recorded in the table do not indicate any appreciable change in soil reaction.

III. Ca+Mg *(Calcium plus Magnesium) in saturated soil extract* :—

The average change in the amount of (Ca+Mg) in the saturated soil extract, has been shown in me/1, in the table below :—

TABLE VI.

S. N.	Depth of Soil	Ca+Mg in m.e./l before leaching	Ca+Mg in m. e./l after leaching	Percentage decrease in Ca+Mg.
1.	Surface	1263	—	—
2.	6″	155	66	58%
3.	18″	71	54	24%
4.	30″	64	23	64%
5.	36″	56	41	27%

The table above shows that the leaching has considerably reduced the amount of Ca+Mg at different depths. From the data available one will find maximum reduction 58% in Ca+Mg at 6″ depth while 24%, 64% and 27% reduction in Ca+Mg has taken place at depths of 18″, 30″ and 36″ respectively. The data for surface is not available.

IV. *Gypsum Requirement (G. R.)* :—Looking to the columns 5 of table I, for the values of gypsum requirement (G. R.) before leaching, it is evident that there does not seem to be sodic problem up to the depth of 30″. The G. R. values have been found to be negative. It is only between 30 to 36 inches that the G. R. values are positive, indicating the sodium problem. That the G. R. Values are of mostly negative, it goes to show that soluble calcium is present in the soil in sufficient quantity.

Column 4 of Table II shows that after leaching, the gypsum requirement (G. R.) has undergone some change particularly for the soil samples for location "W" in the saline patch. The changes at other locations "N" and "C" are not very conclusive.

It is recommended that it is advisable to use gypsum in conjunction with leaching while reclaiming a saline soil. The idea behind this recommedation is that the addition of gypsum will improve the soil structure (particularly permeability) which will hasten the downward movement of white alkali (soluble salts). As stated earlier saline soils have good permeability, but when the salts are leached down, deflocculation results and the permeability decreases. Hence addition of gypsum is expected to counteract this undesirable effect.

In our present programme, gypsum was not added during the process of leaching, but as will be seen later, the hydraulic conductivity was not affected adversely probably for reasons discussed in the section following.

V. Hydraulic conductivity:—The hydraulic conductivity is one of the most important properties connected with soil structure. Determinations of hydraulic conductivity was made before as well as after leaching. The results are shown in column 6 of the table I and II. Ordinarily, after the leaching is done on a saline soil, permeability is expected to decrease and that is why, addition of gypsum, is recommended in conjunction with leaching, to improve the soil structure. But in the present case without any addition of gypsum, the permeability has not been affected adversely, on the contrary, it will be seen from the tables mentioned above that permeability (hydraulic conductivity in this case) appears to have increased. This contradiction can be explained as follows:—

Leaching programme was carried out in the summer months (April to June). After flooding the plot with water, it was allowed to get dry for fifteen or more days, then second leaching and then drying for three weeks and then leaching again. It appears that in the leaching programme, the adaption of alternate wetting and drying process, has done much (or probably more) to prevent the deflocculation of the soil, which would have resulted after leaching, and would have decreased permeability. Thus in this programme alternate wetting and drying has played very significant part in improving the soil structure.

VI. *Base-exchange capacity (B. E. C.)* :—The determinations of base exchange capacity also was made for the soil samples before as well as after leaching. The results are recorded in table I and II column 7. There seems to be appreciable variability. It may be pointed that the determinations on base exchange capacity as well as gypsum requirements are being further checked to insure the results.

Summary and Conclusions.

Leaching as a measure for effecting reclamation of a saline land is sure success method provided that the soil is permeable and drainage conditions are satisfactory. It may further be noted that alternate wetting and drying which have very beneficial effects on soil-structure should be arranged while effecting the programme of leaching on a saline soil. In the present investigations, the salinity as measured by electrical conductivity (E. C.) has been considerably reduced. While the salinity hazard is eliminated or at any rate reduced to a large extent by leaching process, it has certain after effects (such as have been discussed under different determinations), which must be taken note of, by persons concerned.

We are grateful to :—

1. Rockefeller Foundation for their financial help for building up of the Laboratory.
2. T. C. M. (U. S. A.) for providing equipment and guidance of Prof. W. R. Schoonover for the laboratory.
3. I. C. A. R. for granting two Research Fellowships.
4. Prof. W. R. Schoonover for his constructive help in setting up of the laboratory, and his valuable advice, suggestions and guidance in planning and action.
5. Dr. S. A. Taylor, University Soil Physicist Utah State (U. S. A.) for his guidance in selection of apparatus for soil physics.
6. Dr. R. K. Singh (Principal of our college) whose ceaseless efforts and keen interest for Research, have brought the soil salinity Laboratory in existence.
7. Dr. N. K. Anant Rao (Deputy Director, Rural Institute) for his active interest and help in our work.

REFERENCES

1. Diagnosis and Improvement of Saline and Alkali Soils by United States Salinity Staff.
2. Irrigated soils by D. W. Thorne and H. B. Peterson, Utah State University, Utah, U. S. A.

3. Western Fertilizer Handbook Published by Soil Improvement Committee California Fertilizer Association (Calif.).

4. Cheng, K. L. and R. H. Bray (1951) :—Determination of calcium and magnesium in soil and plant material. Soil Sci. 72; 449—58.

5. Connors, J. J. (1950):—Advances in chemical and colorimetric methods, Jour. Amer. Water Works Association. 42 : 33—39.

6. Diehl, H., C. A. Goetz and C. C. Hack (1950) :—The versenate titration, Jour. Amer. Water Works Association. 42 : 40—48.

7. Schoonover, W. R. (1953) :—Examination of soils for alkali quick Tests. California Agri. Ext. Service (Mimeo).

CONDENSATION OF ALDEHYDES WITH PHENYLACETIC ACID.

R. N. Singh and G. N. Kulshreshtha.

Part III—Condensation of p-Hydroxybenzaldehyde and o-Methoxybenzaldehyde with Phenylacetic Acid.

Condensation of p-hydroxybenzaldehyde and o-methoxybenzaldehyde with phenylacetic acid has been successfully accomplished. Three products, namely 4′ hydroxy-stilbene, 4′-acetoxy-stilbene-α-carboxylic and 2′-methoxystilbene-α-Carboxylic acids, have been obtained. Pyridine, piperidine, triethylamine and a mixture of this with acetic anhydride were used as catalysts. The last has proved to be the best. The hydroxy and methoxy groups in the para position have less retarding influence on the reactivity of the carbonyl group of the aldehyde than when they are in the ortho position on the benzene nucleus. The methoxy group, on the whole, retards the reaction to a lesser extent than the hydroxy.

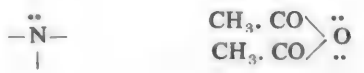
In parts I[1,2] and II[1,3] of this series the genesis of Perkin's reaction and the modifications it underwent from time to time have been described. Among the various factors that have been found to influence the speed of the reaction and the yield of the Condensation product the groups present on the reacting components have been found to play a very significant part. The effect of the various groups in condensation of malonic acid and malonic ester with different aromatic aldehydes has been dealt with in a number of papers by Pandya and Coworkers. Perkin, Lock and Bayer[7] and others have also studied this by using Perkin's method. Condensations of phenylacetic acid and its derivatives have been a subject of study since 1950 in this laboratory. One of the purposes of this study has been to know the effect of the various groups, like hydroxy, methoxy, halogens, nitro etc. on these condensation reactions.

In part I[1,2] condensations of benzaldehyde, salicylaldehyde and anisaldehyde with phenylacetic acid have been reported, wherein pyridine and piperidine only were used as catalysts. These have now been repeated by using triethylamine

Pt. I, appeared in Agra Univ. Journal, 1952.

alone as well as in mixture with acetic anhydride as catalyst. Pyridine as well as triethylamine, both tertiary bases, when used alone as a catalyst, have proved on the whole unsuccessful, although pyridine worked as a very good catalyst in condensations with malonic acid as reported by Pandya and coworkers. When a mixture of triethylamine with acetic anhydride (1 : 3 mol.) was used as a catalyst benzaldehyde gave 80% yield at 180° in 20 hours, salicylaldehyde 76% at 160° in 20 hours, and anisaldehyde 73% at 120° in 36 hours as against 63.3%, 63% and 68.5 % yields obtained by using piperidine as catalyst. The yields now obtained are definitely better than before.

The work reported herewith deals with the condensation of p-hydroxybenzaldehyde and o-methoxybenzaldehyde with phenylacetic acid. Pyridine, piperidine, triethylamine and a mixture of triethylamine with acetic anhydride (1 : 3 mols.) have been used as catalyst. The tertiary bases pyridine and triethylamine (vide explanation given on pages 69 & 70 pt. II)[18] have been found to be less effective than the secondary base piperidine. When triethylamine was used condensation did not take place at all. By using pyridine a low yield of 20% of the condensation product was obtained from o-methoxybenzaldehyde at 120° in 12 hours, whereas no condensation took place at all in the case of p-hydroxybenzaldehyde. This fact, however, proves that a methoxy group, as against a hydroxy one, helps in inducing the reaction. The secondary base piperidine has proved to be more efficacious. p-Hydroxybenzaldehyde gave 45.3% yield of 4-hydroxystilbene at 120° in 24 hours, whereas o-methoxybenzaldehyde gave 63% of 2-methoxystilbene-α-carboxylic acid or α-phenyl-o-methoxycinnamic acid in 12 hours at 160°. The yields showed considerable improvement when triethylamine was used in combination with acetic anhydride in the molecular ratio 1 : 3. Thus p-hydroxybenzaldehyde gave 72.5% of 4'-acetoxystilbene-α-carboxylic acid at 120° in 36 hours and o-methoxybenzaldehyde gave 74.5% of 2-methoxystilbene-α-carboxylic acid at 160° in 12 hours. That the catalytic activity of tertiary bases is much improved by mixing them with acetic anhydride has also been observed by Buckles, Ballis and Codler. This action of acetic anhydride may firstly be attributed to the fact that the acid anhydride being a dehydrating agent removes the water formed from the reacting system and thus accelerates the forward reaction between the aldehyde and phenylacetic acid. Secondly acetic anhydride has two lone pairs of electrons on the anhydride oxygen atom as compared to one lone pair of electrons present on the nitrogen atom of the secondary or tertiary bases and thus is in a stronger position to extract a proton from the reactive methylene group.



As regards the effect of a hydroxy or methoxy group on the condensation reaction this question has been investigated by other workers also. Of all the three positions, o-,m-, and p-, the hydroxy group in the ortho position, as in salicylaldehyde, should ordinarily be most inhibitive.[2, 4, 5, 6] That this should be so is evident from the fact that the hydroxy group in the ortho position should cause maximum steric hinderance. It was expected that the hydroxy group in the para position would cause lesser inhibition, but the experimental evidence put forward by Pandya and other workers is very inconclusive. p-Hydroxybenzaldehyde was first condensed by Tiemann and Herzfeld (1877)[15] by using Perkin's reaction. Later on this was repeated by Eigel[3], Zincke and Leisse[16] and Dutt.[2] These workers got low yields of the condensation products and have not mentioned the effect of the position of the hydroxy group on the condensation reaction. Pandya and Vahidy[8] condensed this aldehyde with malonic acid by using several bases as catalyst and obtained 64% yield of p-coumaric acid in 8 hours at 100°C. Kurien and Pandya [5] had obtained 51% yield only by condensing salicylaldehyde with malonic acid but this was later improved to 64.7% by one of us.[14] On comparing the results of the two hydroxy aldehydes, viz ortho-and para-, Pandya has affirmed to the below-the-expectation yield from the para isomer but has not been able to assign any cogent reasons, and is more or less indecisive.

The picture appears to be clearer when we consider the results obtained by the authors from the condensation of these aldehydes with phenylacetic acid. With pyridine as a catalyst salicylaldehyde gave 14% yield at 160° in 18 hours while the product obtained from p-hydroxybenzaldehyde decomposed with charring even at 140° with six hours of heating. However at 120° in 24 hours the para aldehyde gave 18% yield while the ortho isomer did not condense at all at 140° in 24 hours. Similarly by using piperidine the para-aldehyde gave 45.3% at 120° in 24 hours as against 8% at 120° in 12 hours obtained from the ortho isomer. The results are still better with a mixture of triethylamine and acetic anhydride as catalyst. At 120° in 36 hours the o-and p-aldehydes gave 46.8% and 72.5% yields respectively. Our results are apparently more definite and clearly affirm the fact that the hydroxy group in the para position to the aldehyde group is less inhibitive than in the ortho position. These findings are also in agreement with the theoretical expectation. As the reactivity of a carbonyl group depends upon the ease of formation of a carbonium at the carbonyl carbon atom of the aldyhyde, anything that would interfere with this will retard the reaction. The hydroxy group being a electron donating group retards the formation of carbonium and thus weakens the activity of the carbonyl group. The hydroxy in the ortho position will in addition cause steric hinderance too. The net result would be that the reaction will be slower in the case of salicylaldehyde than in p-hydroxybenzaldehyde.

In the condensation of o-methoxybenzaldehyde with phenylacetic acid the authors found pyridine and triethylamine again as very weak catalysts, the latter being worse than the former. By using piperidine o-methoxybenzaldehyde gave 63% yield of 2′-methoxy-stilbene-α-carboxylic acid or α-phenyl-ortho-methoxycinnamic acid at 160° in 12 hours, as against 68.5% from the para-isomer at 140°. The yields of condensation products from both the aldehydes, however, showed an increase when a mixture of triethylamine and acetic anhydride was used as catalyst. The para aldehyde gave 73% yield at 120° in 36 hours while the ortho one under the same conditions gave a very low yield and to obtain a higher yield of about 74% from this a higher temperature of 160° had to be used. With this catalyst benzaldehyde gave an yield of 80% of the condensation product. These results clearly show that the carbonyl group is more reactive in benzaldehyde than in the case of methoxybenzaldehydes. The presence of the methoxy groups on the benzene ring tends to reduce the reactivity of the carbonyl group. The methoxy group in the ortho position does this to a greater extent than the one in the para position. Like the hydroxy group the methoxy group being electron donating one also hinders the formation of carbonium at the carbonyl carbon atom and slackens the speed of the reaction, the orthomethoxy hindering more than the paramethoxy. These results are in general agreement with those obtained by condensation of these aldehydes with malonic acid,[9] malonanilic acid[10] and amides.[11]

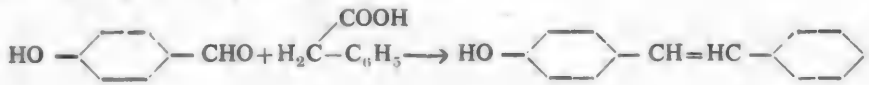
Experimental.

The general procedure was to take the aldyhyde and phenylacetic acid (1 : 1 mol.) in a 50 c. c. round bottom flask and to add the catalyst in the required proportion. Pyridine, piperidine and triethylamine were used in traces (0·15 mol.), whereas triethylamine and acetic anhydride together were used in the ratio of 1 : 3 mol. Different temperatures and periods of heating were tried with all the bases to find out optimum conditions for maximum yield.

Condensation of p-hydroxybenzaldehyde.

The reaction mixture after the reaction was kept overnight and then treated with 10% solution of sodium bicarbonate.

(*i*) The condensation product obtained in the case of piperidine (catalyst) partly dissolved in sodium bicarbonate with effervesence. The insoluble portion (A) was filtered off and the filtrate on extraction with ether yielded unreacted-upon phenylacetic acid. (A) on recrystallisation with benzene melted at 188.° It was neutral, gave a violet colouration with ferric chloride in aqueous solution, and decolorised potassium permanganate solution.



It was identified as 4′-hydroxystilbene. (m. p. 188°). Its acetyl derivative (4′-acetoxystilbene), melted at 152° and methyl ether (4′-methoxystilbene) at 135°. The melting points reported by Heilbron (Dictionary of organic compounds) are 189°, 152° and 135-36° respectively.

(*ii*) In the case of a mixture of triethylamine and acetic anhydride (catalyst) the whole of the condensation product dissolved with effervescence in sodium bicarbonate. The solution was extracted with ether to remove unreacted—upon aldehyde. The aqueous solution on acidification with hydrochloric acid gave a white solid which on recrystallisation from benzene gave needles melting at 174.° This was identified as 4′-acetoxy-stilbene-α-carboxylic acid. Heilbron reports 174° C. Equivalent weight found 282.5 ; $C_{17}H_{14}O_4$ requires 282. On hydrolysis a substance melting at 223° was obtained. Heilbron reports m. p. 223° for 4′-hydroxy-stilbene-α-carboxylic acid.

Condensation with o-methoxybenzaldehyde.

The reaction mixture was treated with 10% sodium bicarbonate solution as before and treated in the usual manner. White needles melting at 186-87° were obtained on recrystallisation from benzene. Heilbron reports the same m. p. of 2′-methoxy-stilbene-α-carboxylic acid. Equivalent weight found 253 ; $C_{16}H_{14}O_3$ requires 254. On distillation it gives 3-phenyl-coumarin m. p. 140 ; Heilbron reports 140-41°.

The following table gives the yields of the products.

Aldehyde	*Condensing Agents*											
	Pyridine			Piperidine			Triethylamine			N Et_3+Ac_2O		
	Temp. C	Time hrs.	Yield %	Temp. C	Time hrs.	Yield %	Temp. C	Time hrs.	Yield %	Temp. C	Time hrs.	Yield %
Benzaldehyde	180	12	—	120	18	63.3	180	12	Trace	180	20	80
Salicylal-	160	18	14	140	18	63	160	18	30	160	20	76.6
dehyde.	120	24	—	120	12	8				120	36	46.8
	140	24	—									
o-Methoxy	120	12	20	160	12	63	180	12	—	160	12	74.5
benzaldehyde				160	18	61				120	12	—
p-Hydroxy	120	18	15	120	24	45.3	120	30	—	120	36	72.5
benzaldehyde	120	24	18	140	6	Chars	140	6	Chars			
p-Methoxy benzaldehyde	170	36	6.2	140	18	68.5	120	30	4	120	36	73

REFERENCES

1. Buckles, Ballis and Codler, 1951, J. Amer. Chem. Soc., 73 : 4972—74
2. Dutt, S., 1925, J. I. C. S., 1 : 298.
3. Eigel, Ber., 20 : 2579.
4. Knoevenagel, 1898, Ber. 31 : 2593 ; D. R. P. 97734.
5. Kurien, P. N., Pandya, K. C., and Surange, V. R., 1934, J. I. C. S. 11 : 823.
6. Kurien, P. N. and Pandya, 1935, Proc. Ind. Acad. Sci. 1 : 775.
7. Lock and Bayer, 1939, Ber. 72 : 1064.
8. Pandya, K. C., and Vahidy, T. A., 1936, Proc. Ind. Acad. Sci., IV : 140.
9. ,, ,, ,1937, Ibid, 5 : 437
10. ,, and Ittyerrah, P. I., 1941, Ibid, 13 : 461.
11. ,, and Mehra, 1939, Ibid, 10 : 285.
12. Singh, R. N., etc., 1952, Agra Univ. Jour. Res., 1 : 153.
13. ,, ,, 1959, B. V. J. Agri. Sci. Res., 1 : 66.
14. Singh, R. N., 1946, Ph. D. thesis Agra Univ.
15. Tiemann and Herzfeld, 1877, Ber., 10 : 65.
16. Zincke and Leisse, Ann. Chem., 322 : 224.

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NOTES

BALWANT VIDYAPEETH AGRICULTURAL FARM BICHPURI (AGRA).

History.

The Balwant Vidyapeeth Farm, at Bichpuri, is situated seven miles from the Agra Collectorate to the west of Agra and four miles from the nearest octroi post on the Agra-Bharatpur road. The Bichpuri station on the meter-gauge of the Western Railway is six furlongs from the Farm.

Prior to 1943 this was a farm of 100 acres of U. P. Government. In that year the Balwant Rajput College, Agra, obtained it, on lease, from the State Government. With the ultimate object of founding a Rural University, with the farm as nucleus, the College acquired 393 acres, contiguous to the original 100-acre farm, against compensation, through the State Government, in September 1949. But the acquisition of this new area could not be completed for a very long time and the College had to face many difficulties during the period 1950-52. The tenants, who were dispossessed of their land, started agitation to get their lands back. This provoked them to destroy and damage the farm crops and property. In July 1952 the College relinquished an area of 60 acres from the new area, as a gesture of good will to the displaced tenants, most of whom were also provided additional land, by the district authorities, in a reclaimed area. Thus the present area of the farm is 433 acres, inclusive of 100 acres Government land on lease.

The transfer of the Government Bichpuri Farm, to the B. R. College, Agra, marks a turning point in its history. As has already been indicated the main consideration with the B. R. College authorities in obtaining the original 100-acre farm, from the Government, in 1943, and later adding another 333 acres to it, in 1949, was to develop a Rural University, with an ideal farm attached to it, on this site, for the betterment of cultivating class of India—particularly of the State of Uttar Pradesh. The beginning of this 'AIM' was made in 1946 with the transfer of post-graduate students, in Agronomy, to this farm to stay and to study. In 1952, post-graduate students, in horticulture, were also shifted to this place from Agra. This was a humble beginning of a much bigger goal and was big enough to justify a change in the designation of the Bichpuri Farm to Bichpuri Centre of B. R. College from its simple identity of a commercial farm.

In 1943, when the College took over this farm from the Government its area was 100 acres total of which was under cultivation. The land was well levelled. The farm had an ideal layout of fields, roads and channels and a farmstead suit-

ably sited and of requisite size. The source of irrigation was a canal (Lower Agra Canal) which flows lower than the level of adjoining fields making 'lift' irrigation necessary. Canal irrigation could be supplemented with water from a surface well fitted with a Persian wheel. This well was mainly meant for domestic water needs of the resident farm families. Power pumps and Persian wheels were used for lifting water at suitable points. The motive power for field work was bullock and both crude and improved bullock-drawn implements were in use for preparatory and inter-cultivation. The main function of the farm was to produce pedigree seed for the cultivators. The farm was managed by a superintendent, with his clerical and supervisory staff, according to the usual practice of Government for such farms.

Upto 1951 the organisation of the farm did not change much except an addition of some agricultural research work by the Post-graduate students, in Agronomy, to its activities. The acquisition of 333 acres, however, brought, with it new problems for the solution of which the necessity for strengthening its management became apparent. This was done in July 1951. Shri O. P. Gautam, M. Sc. Ag.—now Dr. Gautam, Professor of Agronomy at I. A. R. I., New Delhi—an assistant Professor of Agronomy was made the Professor of Farm Management and Manager of the Bichpuri Farm under the overall charge of Dr. N. K. Anant Rao, the then Professor and Head of the Department of Agronomy. An Assistant Farm Manager, to this setup, was further added in November 1953. Since then this system, with necessary modifications now and then, has been operating satisfactorily.

Problems of New Area and their Solutions.

(1) *Source of Power :* As has already been referred to that the 100-acre farm was being cultivated with bullocks. But for efficient and timely operation of the larger unit the use of tractors was felt a necessity. In June 1950, the College invested a sum of Rs. 55,000 on farm machinery and the whole holding of 433 acres was organised as a mechanised unit. During the following year another sum of Rs. 10,000 was invested on farm machinery. In August 1953 again an investment of Rs. 20,000 was made on farm equipment to enable the farm to have, atleast, minimum requirements. Since then no big item, of farm equipment, was added till 1955 during which a second-hand Chevrolet truck was purchased for Rs. 6,000. In 1956-57 a set of farm equipments (one tractor, one disc harrow, one mouldboard plough and one trailer) were purchased, second-hand, for Rs. 4,500 followed by the purchase of a reaper, for Rs. 2,500, in 1958-59. The farm machinery has now become too old for further useful service and needs replacement.

(2) *Layout of area into fields of proper size and shape :* The area, acquired from the cultivators, was made up of numerous small fields of irregular shapes and sizes with varying topographies. As such these fields were quite unsuitable for tractor cultivation. And hence the total area was laid out into fields as far as possible

regular in size and quite big (10 to 15 acres each) for tractor operation. At proper places roads and irrigation channels were provided.

(3) *Problem of irrigation :* The old 100-acre farm was irrigated with canal water. This source of water is, normally, uncertain. With the increase in the farm area this proved insufficient also. Till November 1953 irrigation water was available only for 120 acres. On the rest rainfed crops had to be raised. For making the farm more productive the provision for irrigation facilities became a pressing necessity. And hence the construction of two tubewells (Nos. 1 and 2) was taken up which were completed in the ends of 1953 and 1954 respectively. At present, the total area, under cultivation, is accessible to irrigation water from canal, from tubewell or from both. The provision of sewage, from Kheria Air Field, in 1958-59, has further facilitated irrigation. The Persian wheel on the surface well, formerly meant for domestic water needs of the resident farm families, has now been replaced with a 2-inch pump operated by a 3 H. P. electric motor. This source has assured timely light irrigation to vegetables and orchard.

(4) *Land levelling, irrigation channels and drainage :* Layout of land, into regular fields, and the provision for irrigation needed something more for efficient resource use. As the bigger fields, for tractor cultivation, were made out of the numerous small fields of the cultivators, with varying topographies, the efficient use of irrigation water could not be obtained. In depressions the crops suffered from too much of water, while on elevations they suffered from lack of it. This necessitated levelling of land. For the last good many years, every year, some useful work has been done with the modest means at the disposal of the farm. But even now the fields are not perfectly levelled. Realising well the importance of this factor tractor operated land levelling equipment is under order. Its use will definitely hasten the process very much which will enable better utilisation of irrigation water. The efficient use of irrigation water is further associated with good water courses. Till now most of the important irrigation channels are in mud which cause waste of lot of water through seepage and deep percolation and a fairly big land area, on both the sides of these channels, remains a waste due to stagnation of seepage water. Metalling of these channels, with any suitable material, no doubt, will aid to irrigation efficiency. Equally important is the problem of drainage. During the *kharif* (rainy) season good many crops suffer from water stagnation. Provision of effective surface drainage is thus very important to save rainy season crops from ill-effects of too much of water. At present, there is a plan in hand which contemplates the completion of land levelling, making all the important channels of brick and accomplishing an effective system for surface drainage by June 1963.

(5) *Financial difficulties :* In the beginning of its existence, for several years, the farm experienced financial difficulties which had to be tide over with Government loans, loans from the College, Government subsidies and the earnings of the farm.

To pay off the compensation, to the displaced cultivators, and to finance the immediate needs of the larger unit (purchase of farm machinery etc.) the College obtained a loan of Rs. 2 lakhs from the State Government in 1949 to be paid back at 1.5 per cent interest in 40 instalments. In the first year of working (1950-51) the farm had to take a loan of Rs. 6,000 from the College which it could not pay back. In the second year (1951-52) it again borrowed Rs. 12,000 for its recurring expenses all of which it paid back by the end of the year and also invested Rs. 5,000 in adding new equipment to the farm. In the third year (1952-53) it could manage without taking any loan and since then there has been no financial crisis and in most of the years the farm could run itself smoothly, without any loss, and invested pretty good amounts on capital items. On the construction of two tubewells, referred to above, an amount of Rs. 35,000 was spent. For them a subsidy of Rs. 10,000 (Rs. 5,000 on each well) and a *taccavi* loan of Rs. 13,000 were obtained from the U. P. Government ; the latter has been paid back in instalments. For the electrification of these tubewells, and the campus, a line had to be put over three miles at a cost of Rs. 35,000. This amount is to be paid back in regular instalments and till now (Till Oct. 1959), about Rs. 13,000 have been paid. Due to meeting the annual recurring expenses and financing certain, pretty expensive, capital items from year to year the farm could not build up any reserve fund to replace the farm machinery which now has become quite old. This is being done from the allocation of about Rs. 1.5 lakh, assigned for the purchase of farm equipment, in the Rockefeller Grant of Rs. 13 lakhs and 16 thousand to the College. Mr. Albert Mayer, a well known American architect, has a keen interest in our farm activities. To enable a close supervision of the farm he has donated a sum of Rs. 3,600 for one year (with an assurance for one more year) for adding one more man to the supervisory staff of the farm. This is in support of our scheme to double the farm income within coming 2-3 years. Depending on its earnings the farm has been contributing to the development of College, at Bichpuri, in cash and kind.

Dairy Activities.

With a subsidy of Rs. 20,000, from the State Government, a dairy consisting of Murra buffaloes and Hariana cows was started in October 1950. The herd which had a total strength of 100 animals was, however, transferred to Agra in June 1952 where the 50-acre College farm, at Khandari, was organised as a dairy farm. The maintenance of this dairy, at Bichpuri, for this period, made the farm to sustain a loss of Rs. 15,000 owing to difficulties of milk transport and distribution. At present, the Bichpuri farm has only a small herd of cows of Shahiwal breed, with a total strength of 39 heads (15 cows + 3 heifers + 16 female calves + 4 male calves + 1 bull), to cater to the milk need of people living on this campus. With the increase in the number of residents, on this campus, this herd is now not capable to supply the milk demand. The herd, at the Khandari farm, is expected to be transferred to

this place shortly, with the Post-graduate class in Dairy Science, which may help to meet the milk needs of the total campus.

Research Activities.

The beginning of the research activities, at this centre, dates back to the year 1946 when the Post-graduate students, in Agronomy, were shifted to this place from Agra. In 1952, the research work in Horticulture also started with the transfer of Post-graduate students in this subject. Since 1949 a few students also started research work for Ph. D. degree in Agriculture. Now the research activities have increased very much and every season about 30–40 acres of land remains under experimental crops of the students and staff. In addition, three schemes of I. C. A. R.—Model Agronomic Centre, Weed Control Scheme and Implements Scheme—are operating at this centre which are totally, or partially, financed by the I. C. A. R. Every year a few experiments from U. P. Department of Agriculture—particularly varietal trials—are also conducted at the farm to provide them information for the Agra tract. These trials are of great use to the farm also. Since 1956 a Soil salinity laboratory has also been added to the research activities where work on saline soils and brakish irrigation water is in progress under the guidance of an American expert of T. C. M., Prof. Schoonover. For the last one year Dr. Mellor, Associate Professor of Agricultural Economics at the Cornell University of U. S. A., has been working on certain Agricultural Economics and Farm Management problems, in the surrounding villages as a fellow of Council of Economic and Cultural Affairs, New York, U. S. A.

The aim of research activities is to find out answers to the farm immediate problems which are also the problems of neighbouring cultivators. Valuable results have been obtained on varietal and cultivation aspects of various field and vegetable crops of the region e. g. wheat, gram. peas, bajra, jowar, maize, potato, colecrops and onions. Among our latest undertakings the most important are the studies on soil fertility and plant population relationships in different crops, irrigational studies and propagation, through vegetative cuttings, in fruit plants particularly in *falsa* and citrus.

Cropping Pattern.

It has already been indicated that during the last three years there has been a sizeable reduction in the cultivated area of the farm due to the development of the Vidyapeeth buildings on this site. Out of the total land area of 433 acres only about an area of 300 acres is under cultivation (including orchards) at present.

Eleven acres are under orchards. Major part of this is under guava. Next in importance are citrus fruits among which grapefruit is the main. There are a few trees of mango also.

About ten acres are under vegetables. The aim of vegetable production, on this farm, is to make this centre self-sufficient in vegetables both in variety and quantity. Experience indicates that the production of vegetables, here, for sale in the Agra market, is economically unsound. All important vegetables, of the tract, are grown in their respective seasons. Potato, tomato, colecrops, cucurbits, okra, brinjals and the onions are the main vegetable crops of the farm.

The rest of the area is devoted to the field crops which are grown during both the main crop seasons *viz. kharif* (rainy) and *rabi* (winter) ; the latter being more important. During the last three years 1956-59, the kharif crops contributed only 6, 20 and 15 per cent to the total annual gross incomes. Rest, 94, 80 and 85 per cent, were contributed by the rabi crops. *Bajra*, for grain, and *jowar*, for fodder, are the two main money earning crops of kharif while cotton, paddy, *urd*, *moong* and *til* are the minor ones. During this season (kharif) *sanai* is raised, for green manuring of the following crops of wheat and potato, over about 50 acres. The main crop of the rabi season is wheat which occupies about 150 acres annually. The next two important crops of this season are gram and peas. Barley, sugarcane and fodder crops of berseem and lucerne are minor crops of the rabi season.

From the point of view of area and income this farm may be designated as a 'Wheat farm'. In reality on wheat depends the whole economy of this farm. During the above three years (1956-59) wheat occupied 71, 78 and 58 per cent of the total *rabi* cropped area yielding 78, 63 and 68 per cent of the total annual gross incomes respectively. Wheat is rotated with all the crops grown in the kharif season. The few typical rotations, in practice, are as follows :

1	Sanai—wheat	1 year
2.	Jowar or bajra—berseem	1 year
3.	Green manuring—potato—bhindi or onion	1 year
4.	Cotton—gram or pea	1 year
5.	Sanai (G. M.)—wheat—jowar or bajra—wheat or gram or pea	2 years
6.	Cotton—sugarcane—ratoon—sanai—wheat	4 years

Future of the Farm.

For the last three years (since 1955-56) the farm has been gradually losing area owing to the development of Institutional buildings on this site. The present area under cultivation is about 300 acres, inclusive of vegetable area and orchards. But the activities are increasing. Research work has increased very much which, sometimes, competes for resources—particularly labour—with the commercial crops of the farm. The present area under orchards is 11 acres and there is a plan to

increase the area under commercial and demonstrational orchards to about 40 acres. The dairy herd from the Khandari farm is expected to come here very soon. This may need some change in the cropping pattern—the area under fodder crops may have to be increased. Other departments of faculties of science and agriculture, of the College, which are in the process of shifting to this place, having something to do allied to Agriculture may also place their demand on land. These may cause further decrease in the farm area under commercial farming. The farm is also adding to its present number of enterprises. A small piggery unit has already started as also an apiary unit. Plans for starting pisciculture and sericulture are under active consideration. The aim is to make this farm a place where a working training in these enterprises may be made available to the students.

M. L. Gupta.

A LIST OF THESES SUBMITTED TO THE AGRA UNIVERSITY THROUGH THE B. R. COLLEGE IN 'AGRONOMY' (TILL 1959).

CLASSIFICATION OF THE THESES.

(At post graduate level)

Class No.	Title of the Class	No. of theses written
I	Manurial and Irrigational	65
II	Varietal and Manurial	21
III	Weeds and weed control	15
IV	Drought resistance	3
V	Dry farming and water requirement.	4
VI	Presowing seed treatments	5
VII	Cultural	15
VIII	Soil salinity	2
IX	Mixed cropping and rotational	9
X	Miscellaneous	3
	(At Ph. D. level)	
I	Manurial	1
II	Mineral Nutrition	1
III	Weed Control	1

The details of the titles of theses in each of the above class are given in the following pages.

S. N.	Title of the Theses	Year
	I. Manurial and Irrigational.	
	Wheat.	
1	'Effect of N, P and K, each at three levels, singly and in combination, on wheat.	1948
2	Study of the effects of two forms of nitrogen at three levels, each at two levels of irrigation, on growth and yield of wheat.	1948
3	The effect of levels and time of application of nitrogen and phosphorus on growth, performance, yield and protein content of grain of wheat crop.	1948
4	The effect of nitrogen with varying doses and times on wheat.	1948
5	Effect of increasing doses of nitrogen in the form of ammonium sulphate, with and without basal dressing of organic manures, on wheat.	1948
6	Study of the effect of organic and inorganic nitrogen, singly and in combination, with varying levels of irrigation, on growth. yield and chemical constituents of wheat and the residual effect on jowar.	1948
7	Effect of nitrogen, phosphorus and potash each at three levels, singly and in combination, on wheat crop.	1949
8	The effect of nitrogen on wheat as applied in different instalments.	1949
9	Effect of nitrogenous manuring on wheat.	1949
10	Response of wheat to N, P, K, fertilizers.	1959
11	Influence of different doses and times of application of nitrogen and phosphorus on wheat.	1950
12	Effect of N, P and K fertilizers on wheat.	1950
13	Effect of three forms of nitrogen in three doses and their interaction with three levels of irrigation on wheat.	1951

S. N.	Title of the Theses	Year
14	Effect of two forms of phosphate on wheat crop, each on wheat crop, each at two levels applied at four varying depths.	1951
15	Effect of two forms of phosphate, each at four levels, applied at three times, on green manured wheat.	1952
16	Studies on the effect of six forms of concentrated phosphate, each applied at four doses on growth, development and yield of wheat.	1952
17	Studies on placement of fertilizers on wheat.	1952
18	Effect of inorganic and organic nitrogenous manures on wheat.	1952
19	Effect of increasing levels of nitrogen with and without basal dressing of compost on growth, development and yield of wheat.	1952
20	Phosphate manuring of sanai and its residual effect on wheat.	1953
21	Phosphate manuring of sanai (G. M.) and residual effect on wheat.	1954
22	Phosphate manuring of Moong and residual effect on wheat.	1954
23	Effect of different green manuring crops with and without phosphate on soil fertility and wheat yield.	1955
24	Studies on green manuring of wheat.	1955
25	Comparative performance of different green manure crops with and without their after effect on the uptake of nitrogen on yield of wheat.	1956
26	A comparative study of different methods of urea application on the growth, yield and quality of wheat.	1957
27	"Effects of two forms of phosphorus (Superphosphate and Amophos) applied as broad-cast, 2½ inches below the seed and by bend placement, and at the rates of 20 lbs. and 40 lbs. P_2O_5 per acre on growth and yield of wheat."	1959

S. N.	Title of the Theses	Year
28	"A comparative study of efficiency of nitrogen application to wheat grown either after fallow or after green manuring with legumes (Urd or Mung) fertilized with and without Phosphorus ."	1959
	Maize.	
1	Effect of N-P fertilizer on maize and residual effect on wheat.	1951
2	Effect of nitrogen and phosphorus, each at three levels, singly and in combination, on growth and yield of maize.	1953
3	Placement studies of fertilizers on maize.	1954
4	Effect of manuring and spacing on leaf area and yield of wheat.	1955
5	Effect of manuring and spacing on maize.	1955
	Cotton.	
1	Effect of increasing levels of nitrogen on growth, development and yield of cotton, 35/1.	1953
2	Effect on nitrogenous manuring applied at different times with and without basal dressing on growth, development and yield of Cotton 35/1.	1953
3	Studies on the manuring of Cotton.	1954
4	Studies on the manuring of cotton, Ammonium sulphate (40 lb N/acre) applied at different stages of growth with and without phosphorus.	1958
5	Effect of varying plant populations and levels of nitrogen on growth, yield and quality of cotton, 216 F.	1958
6	Response of cotton, 216 F, to three doses of nitrogen through urea and ammonium sulphate applied at two stages of life cycle.	1958

S. N.	Title of the Theses	Year
7	Effects of manurial and plant spacing treatments on the growth, yield and quality of cotton, 216 F.	1959
	Bajra.	
1	Studies on the effect of variations in plant density and soil fertility on development and yield of Bajra.	1955
2	Effect of variations on plant density and soil fertility on growth and yield of Bajra.	1955
3	Effect of different instalments of nitrogen application on yield and quality of Bajra with and without phosphorus.	1956
4	Effect of different instalments of nitrogen application on growth, development and yield of Bajra with and without phosphorus.	1956
5	Effect of different instalments of nitrogen application with and without phosphorus on growth, yield and nitrogen content of Bajra.	1957
6	A study of the variations in growth, yield and quality of Bajra as affected by methods of sowing, time of application and forms of nitrogen manures.	1959
7	Studies on the effect of variation in plant density at varying nitrogen levels with and without phosphorus on growth, yield and quality of Bajra.	1959
	Barley.	
1	Effect of different levels of nitrogen or phosphorus or in combination on the growth and yield of barley.	1948
2	Effect of nitrogen at different levels in organic and inorganic forms on the growth and yield of barley.	1948
3	Studies on the influence of levels of nitrogen and different methods of its application on growth, yield and chemical composition of barley.	1948

S. N.	Title of the Theses	Year
	Gram.	
1	Effect of N, P and K, singly and in combination on growth development and yield of gram.	1952
	Moong.	
1	Effect of major plant nutrients (N, P and K) and micro nutrients on growth, development and yield of moong.	1953
2	Effect of phosphate and its placement on Moong.	1953
3	Phosphate manuring of Moong and its residual effect on wheat.	1953
	Potato.	
1	Effect of nitrogenous manuring on potato.	1950
2	Effect of increasing levels of two forms of potash applied with and without dressing of municipal compost upon growth, yield and quality of potatoes.	1957
3	Effect of varying spacings and levels of Nitrogen applied in the form of ammonium sulphate and Compost on growth yield and quality of potatoes.	1959
	Berseem.	
1	Studies of the response of berseem to varying levels of phosphorus, applied as super phosphate, with two levels of irrigation and three seed rates and its after effect on succeeding wheat crop.	1952
	Jowar.	
1	Effect of increasing levels of nitrogen with and without the basal dressing of compost on growth, development and yield of Jowar fodder.	1953
2	Effect of increasing levels of nitrogen 10, 15, 30, 45, 60, 75, 90 and 105 lb/ acre applied as ammonium sulphate on Jowar fodder and residual effect on gram.	1953

S. N.	Title of the Theses	Year
	Sesam.	
1	Effect of N, P and K, each at two levels, singly and in combination, on yield and oil content of sesame.	1956
	Pea.	
1	Effect of increasing levels of phosphorus on growth, development and pod yield of three varieties of wheat.	1957
	Coriander	
1	Effect of nitrogen, phosphorus and potash, singly and in combination, on the growth, development and yield of coriander.	1950
	Paddy.	
1	Effect of A/A, sodium nitrate and their mixture, each applied at 40 lb N/acre on paddy with and without a basal dressing of compost at 20lb N/acre.	1954
2	Influence of four levels of nitrogen with and without phosphorus on growth and yield of paddy.	1956
	II. Varietal and Manurial.	
	Wheat.	
1	Response of three varieties of wheat to three forms of nitrogen in three different doses and their interaction with three levels of irrigation.	1950
2	Effect of different levels of nitrogen and phosphorus, singly and in combination, on growth, and yield of different varieties of wheat.	1950
3	Growth and yield/plant of three varieties of wheat as influenced by three forms of nitrogen, applied in three doses and their interaction with three levels of irrigation.	1951

S. N.	Title of the Theses	Year
4	Developmental studies and plant yield of three varieties of wheat as influenced by three forms of nitrogen in three different doses and their interaction with three levels of irrigation.	1951
5	Developmental studies and plant yield of three varieties of wheat as influenced by N, P and K, each at three levels, applied singly and in combination.	1951
6	Developmental studies and plant yield of three varieties of wheat as influenced by three forms of nitrogen in three different doses and their interaction with three levels of irrigation.	1952
7	Effect of N, P and K, each at three levels, singly and in combination, on the growth and yield of three varieties of wheat.	1952
8	Response of three varieties of wheat to three forms of nitrogen in three doses with three levels of irrigation.	1952
9	Effect of major plant nutrients N, P, K and micronutrients Mg, Mn and B on growth, development and yield of two varieties of wheat (Pb 591 and C 13.)	1952
10	Response of two varieties of wheat (Pb 591 and C 13) to increasing levels of nitrogen.	1957
	Maize.	
1	Effect of variation in plant density and soil fertility on growth and yield of two varieties of maize.	1957
2	Studies on growth and yield of Kansas 1639 and T-4111 varieties of maize as influenced by variations in plant density and soil fertility.	1958
3	Comparative performance of American hybrids and Indian varieties of corn.	1958
4	Comparative performances of 49 varieties of Maize.	1959
5	A varietal trial of Maize.	1959

S. N.	Title of the Theses	Year
	Cotton.	
1	Studies on growth, development and yield of four varieties of Cotton (100 F, M4, 216 F & 35/1).	1953
	Sesame.	
1	Varietal trial of sesame.	1956
	Sugarcane.	
1	Varietal trial of Sugarcane.	1953
	Jowar.	
1	Response of Jowar varieties to nitrogen for grain.	1955
	Gram.	
1	Study of the effects of four levels of phosphorus on growth, development and yield of three varieties of gram.	1958
	III. Weeds and Weed Control.	
1	Studies on weed crop competition.	1949
2	Physical, physiological and agronomical studies on weed flora of the province.	1950
3	Studies on weeds of arable land; Germination, growth and reproductive capacity of weeds associated with gram, barley and mustard, grown singly and mixed under rainfed condition.	1951
4	Succession and characteristics of weeds growing in association with barley, gram and mustard, under rainfed conditions, sown singly or mixed in lines or otherwise.	1952

S. N.	Title of the Theses	Year
5	Effect of sodium 2, 4-D Dichlorophenoxy acetate on weeds of Bajra crop.	1955
6	Effect of weedings under varying levels of soil fertility on leaf area, dry matter, N A R and yield of Bajra.	1955
7	Effect of cultural and chemical--Na 2, 4-D methods of weed control on growth and yield of Jowar under two levels of fertility.	1955
8	Studies of weeds of Jowar field and their response to Na 2, 4-D Dichlorophenoxy acetate.	1955
9	Effect of weed control with 2, 4-D on growth and yield of Bajra.	1955
10	Effect of weeding under varying levels of soil fertility on Bajra crop.	1955
11	Studies on Cyperurs torundus.	1956
12	Studies on chemical and mechanical methods of weed control in maize and performance of chemical weed control in wheat.	1956
13	Comparative study of chemical and mechanical methods of weed control in maize crop.	1957
14	Weed control studies in corn by 2, 4-D sodium salt spray and in three concentrations and at three times with and without hand weeding.	1957
15	Weed control studies in wheat using varying concentrations of ester and amine forms of 2, 4-D Salt at pre and post emergence stages.	1959
	IV. Drought Resistance.	
1	Drought resistance in wheat.	1949
2	Drought resistance in wheat.	1950

S. N.	Title of the Theses	Year
3	Drought resistance in cereals.	1951
	V. Dry Farming and Water Requirement.	
1	Investigations on the suitability of different rabi crops under rainfed conditions in arid regions.	1948
2	Experimental studies on the suitability of different rabi crops to rainfed condition in arid regions.	1949
3	Water requirement of crops.	1949
4	Growth, water requirement and yield of two varieties of Moong as influenced by two levels of soil moisture with and without phosphorus.	1953
	VI. Presowing Seed Treatments.	
1	Vernalization response of wheat, gram and mustard.	1949
2	Vernalization response in Indian wheats.	1950
3	Effect of presowing seed treatments and survival and recovery when subjected to severe winter killing.	1950
4	Vernalization response of mustard.	1950
5	Effect of presoaking of seeds in three concentrations of three phosphate carriers for four different durations on development, growth and yield of wheat.	1952
	VII. Cultural.	
1	Response of three varieties of potato to three sowing dates.	1950
2	Response of two varieties of wheat to different dates and methods of sowing.	1950
3	Developmental studies and plant yield of three varieties of wheat as influenced by three sowing dates and three seed rates.	1951

S. N.	Title of the Theses	Year
4	Response of three varieties of wheat to different sowing dates and seeding rates.	1951
5	Developmental studies on varieties of wheat as influenced by cultural practices i. e. weeding and harrowing. Developmental studies on weeds associated with wheat crop.	1951
6	Response of two varieties of wheat to give different dates of sowing and three rates of seeding.	1952
7	Developmental studies and plant yield of two varieties of wheat as influenced by five sowing dates and three seed rates.	1952
8	Developmental studies and plant yield of two varieties of wheat as influenced by five dates of sowing and three seed rates.	1952
9	Growth studies on three varieties of wheat as influenced by cultural practices, weeding and harrowing. Growth, studies on weed associated with wheat crop.	1953
10	Studies on Bajra.	1954
11	Effect of different spacings on leaf area Index and yield of Bajra.	1955
12	Studies of different spacings on Bajra crop.	1955
13	Study of varying seed rates with increasing levels of nitrogen affecting growth and yield of wheat.	1957
14	Mixed cropping practiced affecting growth and yield of Bajra Urd and Bajra Mung mixtures when sown either in lines or broadcast using different proportions of seeds.	1959
15	Associated growth of legumes (Lentil or gram) and cereals (wheat) as affected by levels of irrigation and methods of sowing.	1959
	VIII. Soil Salinity.	
1	Effect of irrigation water of varying salinity on vegetable crops.	1957

S. N.	Title of the Theses	Year
2	Effect of irrigation water of varying salinity on field crops,	1957
	IX. Mixed Cropping and Rotational.	
1	Mixed cropping under irrigation and rainfed conditions and developmental studies in wheat, barley and gram.	1950
2	Mixed cropping under rainfed conditions and root development studies in barley, gram and mustard.	1951
3	Studies on mixed cropping.	1952
4	Studies on mixed cropping.	1953
5	Studies on growth, yield and quality of fodder (Jowar-guar) grown singly and in mixture, with and without fertilizers.	1956
6	Studies on the suitability of Kharif crops for rotation with wheat.	1956
7	Economics of wheat and mustard mixture.	1957
8	Studies on growth, yield and quality of jowar and guar fodders as influenced by sowing methods and fertility levels,	1958
9	Economice of wheat and mustard mixtures, three mustards (y. s. 151, Laha 101 and R. T. 11) sown in lines 6′ and 9′ apart in wheat.	1958
	X. Miscellaneous.	
1	Role of light and nitrogen on wheat. Effect of three durations of light with varying levels of nitrogen, on the growth and development of wheat.	1949
2	Physiological analysis of yield of Jowar.	1955
3	Studies on green manuring.	1954

THESES AT Ph. D. EVEL

S. No.	Title of the Theses	Writer	Year
	I. Manurial.		
1	Experimental studies into the influence of varying rates of superphosphate, placed at different depths, with and without, ammonium sulphate, on growth, development, uptake of N and $P_2 O_5$ and yield of wheat.	Gajadhar Singh	1955
	II. Mineral Nutrition.		
1	Iron in relation to wheat.	Ram Murat Singh	1955
	III. Weed Control.		
1	Studies on weeds and weeding of wheat field.	H. K. Pande	1955

The B. V. Journal of Agricultural & Scientific Research

The Journal is published six monthly—in January and July. It publishes, in main, the research papers based on the research work already done and being done in different departments of Agriculture and Science faculties at the Balwant Vidyapeeth, Agra, notes regarding the nature of research work being done and being planned, and book reviews.

The books for review should be sent to the Hony. Editor by the end of October and May for the January and July issues respectively.

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